INSTRUCTION MANUAL

TYPE 1A6 DIFFERENTIAL AMPLIFIER

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

This is the
INSTRUCTION MANUAL
for your new
Tektronix Instrument

It contains detailed information about the characteristics, operation, circuit description and calibration of your new instrument.

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INSTRUCTION MANUAL

Serial Number 1519

ATTENUATOR SWITCHING

VERTICAL AMPLIFIER

TYPE 1A6 DIFFERENTIAL AMPLIFIER

Tektronix, Inc.
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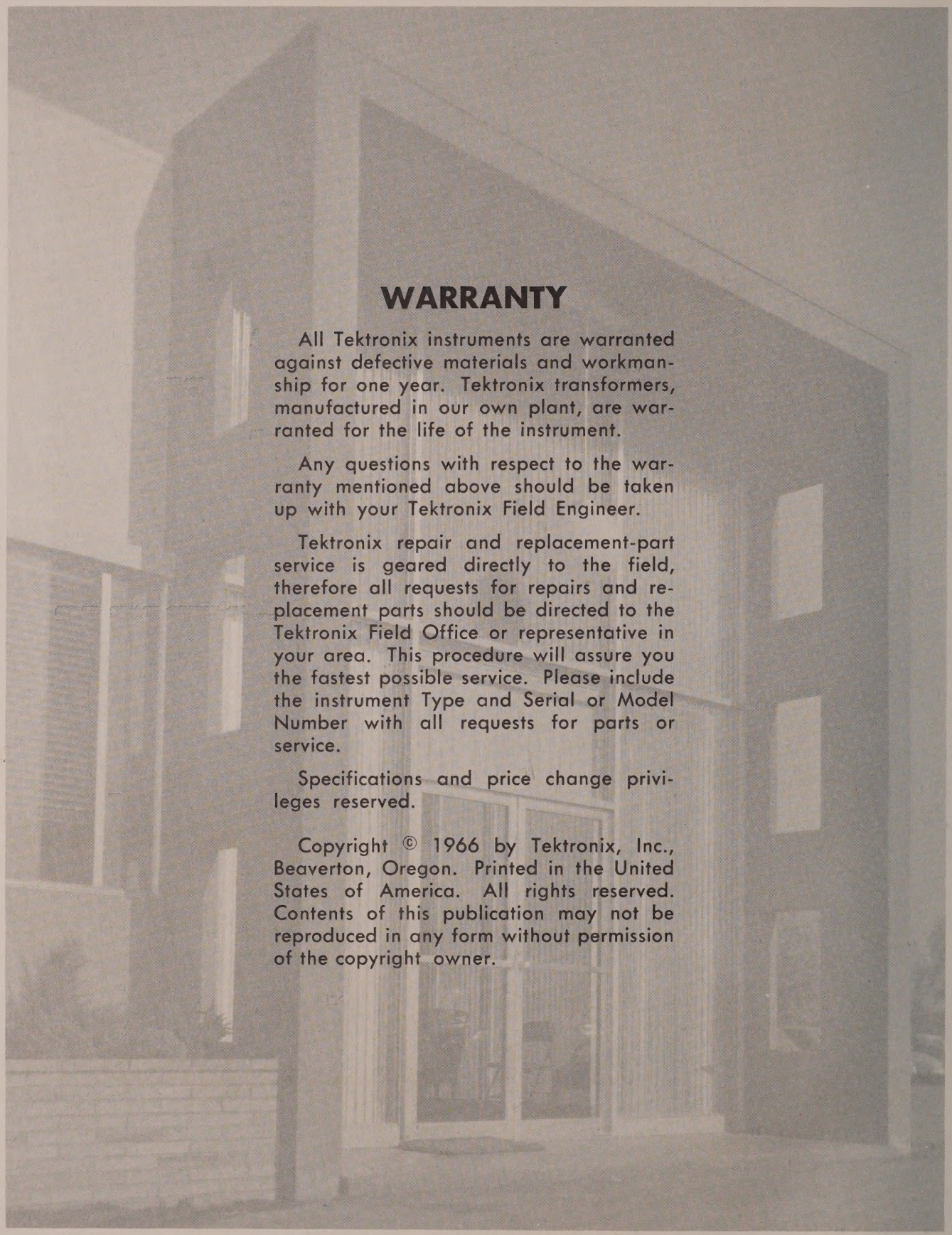

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All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

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Abbreviations and symbols used in this manual are based on, or taken directly from, IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

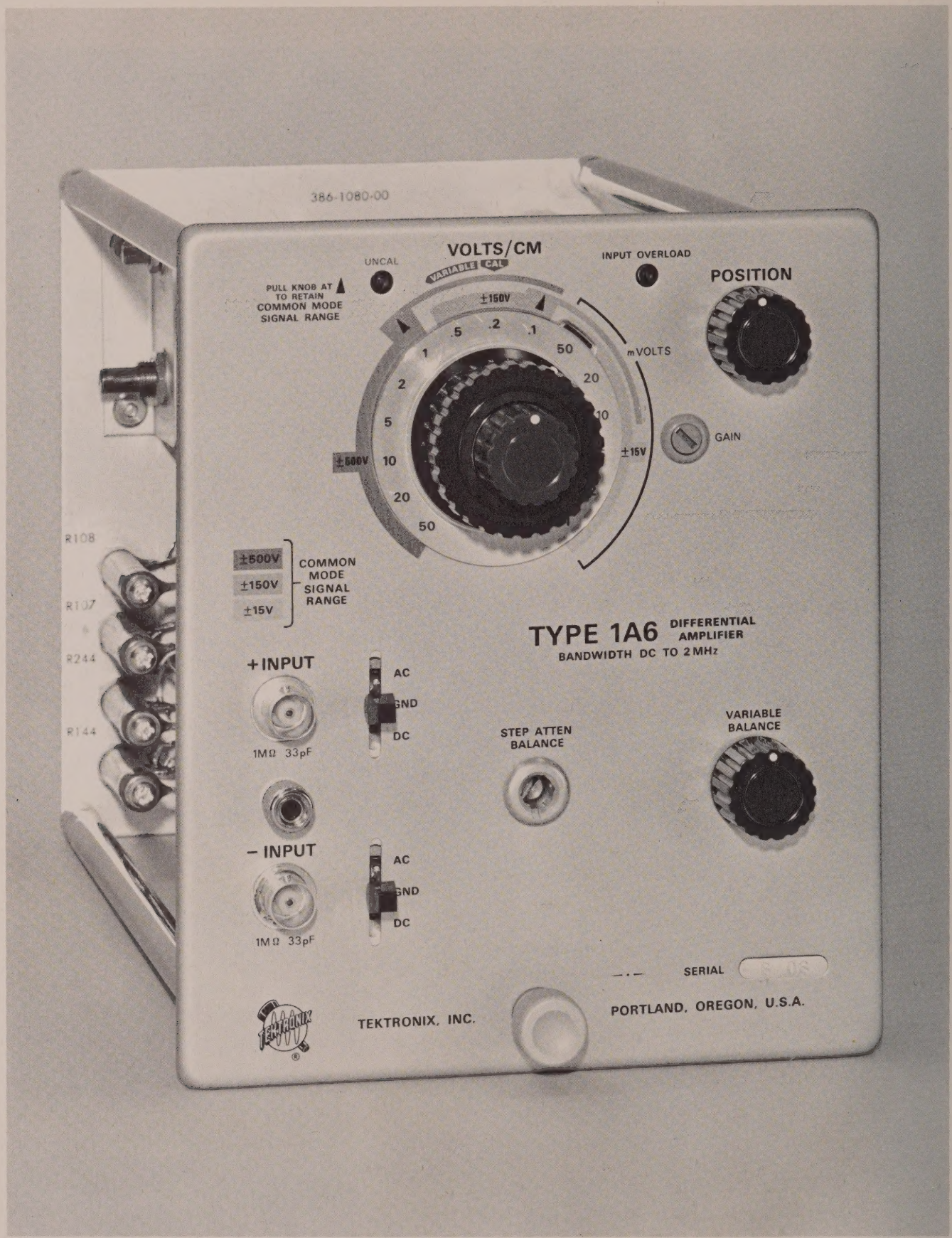


Fig. 1-1. The Type 1A6 Differential Amplifier Plug-In Unit.

SECTION 1
CHARACTERISTICS

Introduction

The Type 1A6 Differential Amplifier is designed for use with 530, -540, -550, -580[1] Series oscilloscopes. The Type 1A6 features simplified common-mode signal range and deflection factor selection. The bandwidth is constant for all deflection factor ranges. Each input provides AC, ground and DC coupling with GND between the AC and DC positions to allow the coupling capacitor to be charged before switching to AC.

This instrument will perform to specifications in laboratory environment with ambient temperature range from 0° C to 50° C except as indicated. Warm-up time for rated accuracies at 25° C ±5° C is 30 minutes.

MECHANICAL FEATURES

Construction	Aluminum alloy chassis. Glass laminate circuit board assembly. Anodized front panel.

Standard accessories supplied with the instrument are listed at the end of the Mechanical Parts List section. For optional accessories see Tektronix, Inc. catalog.

ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Bandwidth		
DC Coupled	DC to ≥2 MHz (at −3 dB point)	Equivalent to a risetime of 175 ns or less.
AC Coupled	≤2 Hz to ≥2 MHz (at −3 dB point)	
Transient Response	≤±2% aberration	
Input Cross Neutralization	≤3% aberration for normal amplitude	Adjustable to within 1%. Measured when driven grid is DC coupled and input coupling switch for the undriven grid is set from GND to DC. Aberration on the display is expressed as a percent of the original display amplitude.
DC Drift	≤200 μV per degree C	
VOLTS/CM		
Range		1 mV/CM to 50 V/Cm in 15 calibrated steps, in 1, 2, 5 sequence.
Accuracy		
1 mV to 50 mV	±1.5%	At ambient temperature of +25° C ±5°C.
0.1 V to 50 V	±2.5%	
VARIABLE	Provides continuous variable attenuation of the input signal by a factor of at least 2.5:1.	
Gain Variation (Thermal)		
1 mV/CM to 50 mV/Cm	≤0.5% at +25° C ±10° C ≤±1% at +25° C ±25° C	
.1 V/Cm to 50 V/Cm	≤±1% at +25° C ±10° C ≤±1.5% at +25° C ±25° C	
Common Mode Signal Range		
1 mV/Cm to 50 mV/Cm	≥±15 V (combined DC + peak AC)	
10 mV/Cm to 0.5 V/Cm	≥±150 V (combined DC + peak AC)	
0.1 V/Cm to 50 V/Cm	≥±500 V (combined DC + peak AC)	
Common Mode Rejection Ratio (CMRR)		
DC Coupled		
1 mV/Cm to 50 mV/Cm	≥10,000:1 (DC to 100 kHz)	
0.1 V/Cm to 50 V/Cm	Adjustable to ≥1000:1 (DC to 100 kHz)	
AC Coupled		
1 mV/Cm to 50 mV/Cm	≥2000:1 (at 60 Hz)	
0.1 V/Cm to 50 V/Cm	Adjustable to ≥1000:1 (at 60 Hz)	

[1]Type 81 or Type 81A Plug-In Adapter is required with the Type 580 Series oscilloscope.

ELECTRICAL CHARACTERISTICS (cont)

Characteristic	Performance Requirement	Supplemental Information
Maximum Input Voltage at 1 kHz		
DC Coupled		
1 mV/CM to 50 mV/CM		200 volts DC + peak AC between inputs, or either input and ground
0.1 V/CM to 50 V/CM		±600 volts DC + peak AC at either input
AC Coupled		
1 mV/CM to 50 mV		200 volts AC, peak to peak, differential or common mode
1 mV/CM (using precharge)		±600 volts DC ± peak AC at either input. AC not to exceed 200 volts peak to peak
1 mV/CM (not precharged)		200 volts DC + peak AC between inputs, or either input and ground
0.1 V/CM to 50 V/CM		±600 volts DC + peak AC at either input
Overload Indicator	Neon lights when $\geq +50$ V (referenced to ground) is applied to either or both inputs. Does not light with ≤ 20 V applied.	With no internal or external attenuation.
Input Characteristic	Input resistance of 1 MΩ ±0.75% paralleled by 33 pF ±3%.	Input C adjusted to combine with R for a time constant of 33 μs.

SECTION 2

OPERATING INSTRUCTIONS

Introduction

An oscilloscope with a differential amplifier is a device that amplifies and displays a voltage difference that exists at every instant between signals applied to its two input channels. The following conclusions can be drawn from this definition when two signals are applied to the input of a differential amplifier.

1. If the two signals are in phase and of equal amplitude (hereafter called common-mode) the output will be zero (limited by the common-mode rejection ratio).

2. If the two signals are in phase but of different amplitude the output will equal the amplitude difference. See Fig. 2-1.

3. If the two signals are out of phase and of equal amplitude, the output will be the vector difference between the two signals. See Fig. 2-2.

4. If the two signals are out of phase and of different amplitude the output signal is a complex quantity derived from both amplitude and phase differences. See Fig. 2-3.

This section describes differential amplifier characteristics such as common mode rejection, dynamic and frequency range, basic measurement technique and general information on the Type 1A6. The Type 1A6 information covers the function of each control and first time operational procedure with some typical differential measurements.

Common-Mode Rejection

The definition of the term "differential amplifier" implies a rejection of equal amplitude, coincident signals. This implication is correct. However, the degree of rejection depends primarily on the symmetry of the amplifier inputs. The amount of difference signal from a particular amplifier is documented with a mathematical relationship that is called the common-mode rejection ratio (CMRR). This ratio and associated terms are defined as follows:

Common-Mode: Refers to signals that are identical with respect to both amplitude and time.

Common-Mode Rejection: The ability of a differential amplifier to reject common-mode signals.

Common-Mode Rejection Ratio (CMRR): The ratio of the amplitude of the comon-mode input signal to the difference input signal which would produce the same deflection on the CRT screen.

NOTE

Since the differential amplifier is part of an oscilloscope, the output signal used to calculate the CMRR is measured from the CRT screen and volts per centimeters switch setting. Thus, a differential amplifier that produces a .005-volt output when driven by 5.0 volts of common-mode signal has a CMRR of 5/.005 or 1000:1.

Amplitude and Common-Mode Rejection

In the text to follow, the term maximum common-mode input voltage means the maximum voltage that will not overdrive the amplifier. This should not be confused with the maximum non-destructive input voltage, which is related to the breakdown limits of the amplifier components.

Factors Which Affect CMRR

Frequency: Since the common-mode output voltage is a factor of phase difference as well as gain between channels, the frequency of the input common-mode signal has a direct bearing on the CMRR. Generally as the frequency of the input signal increases the CMRR decreases. (Exception: with AC-coupled input the CMRR can become higher as frequency is increased within the 1 Hz to 100 Hz range).

Source Impedance: The specified CMRR assumes that the points being measured have identical source impedance. The source impedance and the amplifier input impedance

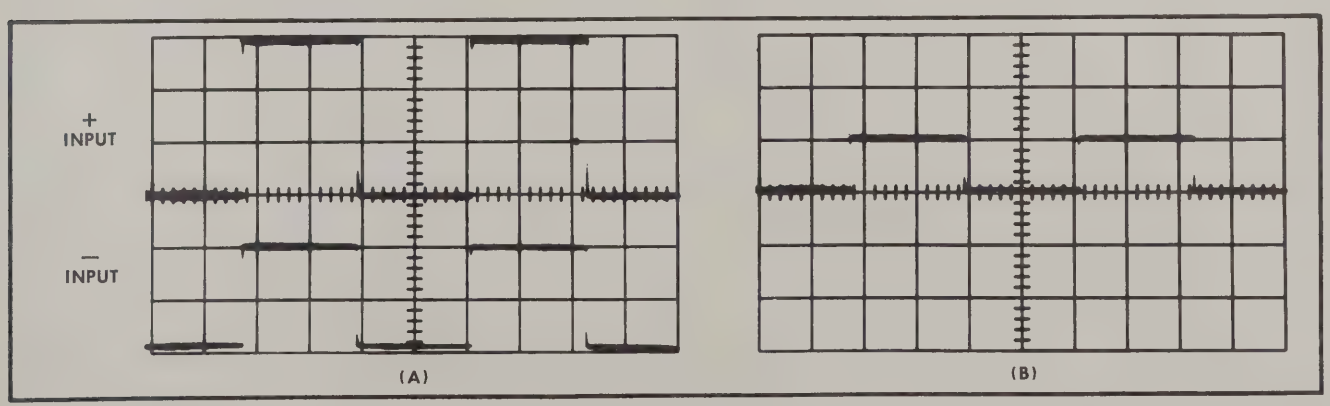


Fig. 2-1. (A) Upper signal applied to + Input and lower signal applied to — Input. (B) The resultant output signal.

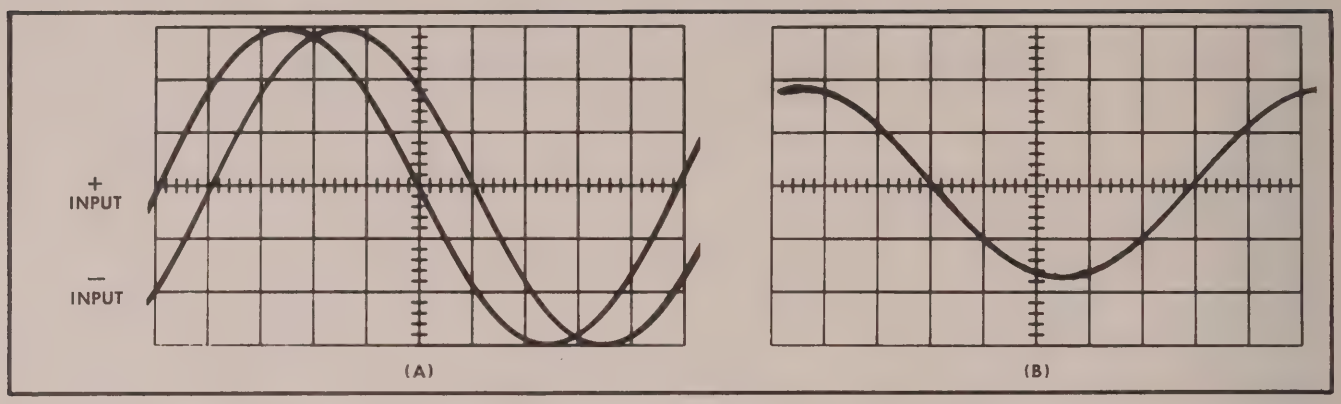


Fig. 2-2. (A) Leading signal applied to + Input and lagging signal applied to — Input. (B) The resultant output waveform display.

form an RC divider which determines the portion of the signal that appears across the amplifier input, and the apparent effect on CMRR. See Fig. 2-4.

Signal Transporting Leads: A principal requirement for maximum CMRR is that the signals arrive at the two amplifier inputs in precisely the same phase and amplitude. Slight differences in attenuation factors, or phase shift between two input attenuators may reduce the CMRR, 20% or more.

Attenuator probes extend the usable voltage range of a differential amplifier by reducing the input signal level below the maximum common-mode input voltage. However, the probes may cause a reduction in the apparent CMRR due to component value differences within the probes. For example, Fig. 2-5 illustrates the change in CMRR (apparent) due to ×10 probes that are within 1, 2, and 3% of their attenuation value.

In measurements where attenuator probes must be used because of high voltage levels, and at the same time a high (above 100:1) CMRR must be maintained, the Tektronix Type P6023 Probe is recommended. This is a ×10 low capacitance probe with variable attenuator ratio that is adjustable over a ±2.5% range.

Ground Connections: Proper grounding reduces signals generated from ground loop currents. It is best to electrically connect the probe or signal lead shields together at the probe body or signal source, but not to the instrument ground. See Fig. 2-6.

Differential Amplifier Applications

In differential measurements each input of the amplifier acts as a reference for the other and ground connections are only used for safety reasons. (The term differential input is synonymous with floating input). Fig. 2-7 illustrates a typical differential measurement application.

In application such as examining a signal superimposed on some DC level with DC coupling, an offset voltage may be applied to the other input of the differential amplifier to slide the signal back on the CRT screen. For example, if a differential amplifier is set for a vertical sensitivity of 10 mV/cm (trace on-screen) and a +1 volt DC voltage is applied to input A, the trace will be deflected upward off screen. If a +1 volt DC voltage is now applied to input B, the trace will return on screen, or the signal slides back on-screen as a result of the voltage (slide-back voltage) applied to input B. The DC voltage applied to input B is in effect common-mode with that of input A, thus both are rejected by the amplifier.

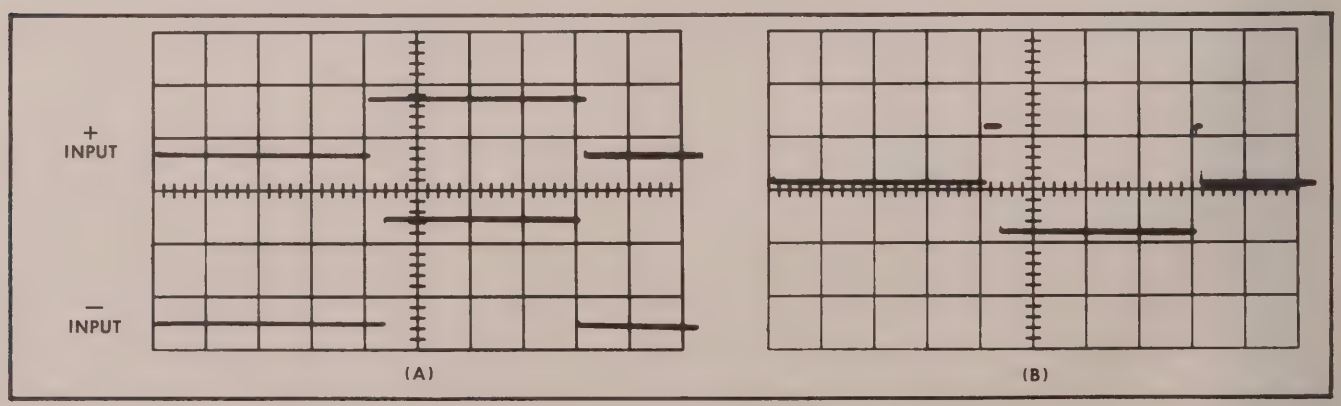


Fig 2-3. (A) Upper signal applied to + Input and lower signal applied to the — Input. (B) The resultant difference waveform seen on CRT.

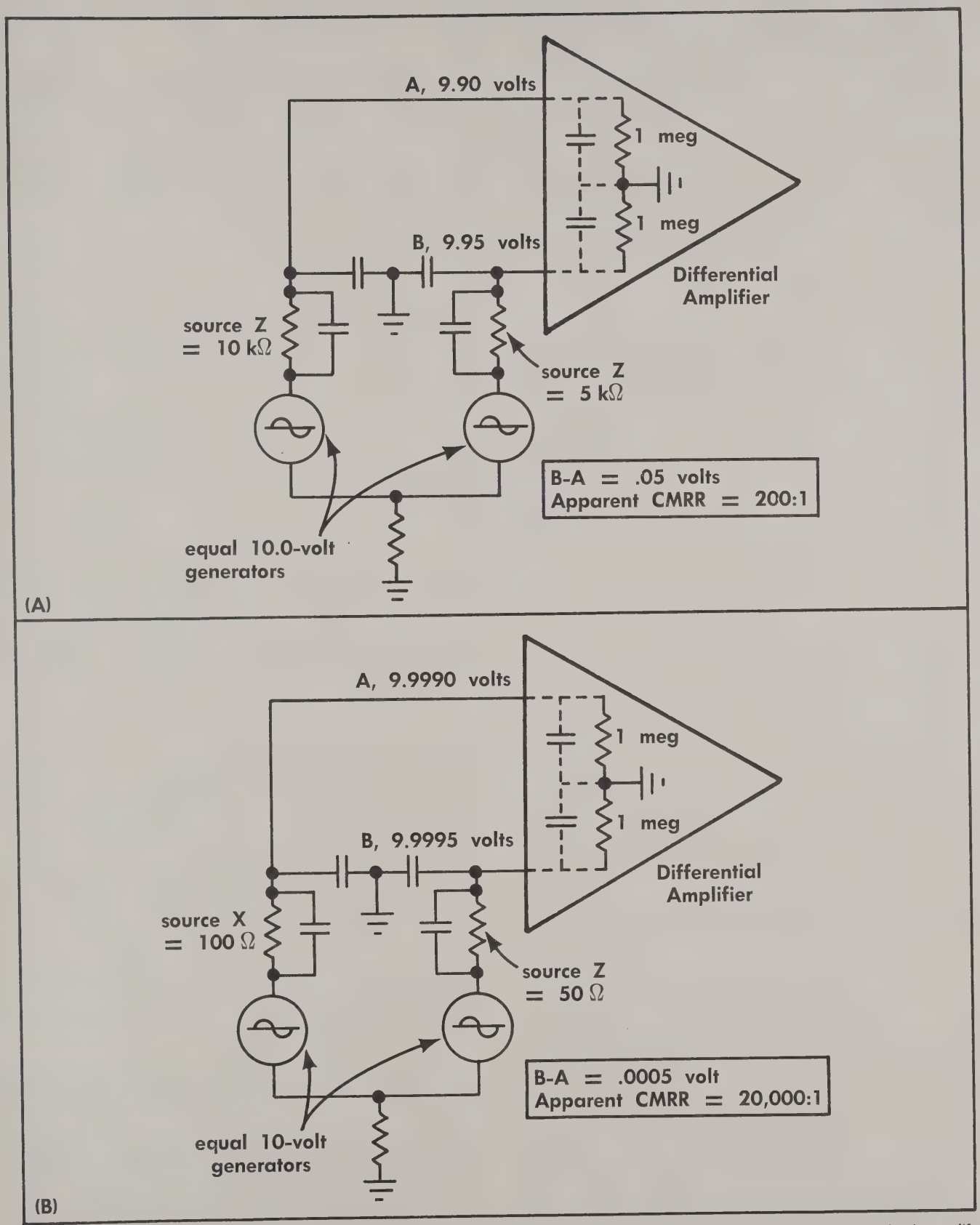


Fig. 2-4. (A) Relationship of test-point source impedance to the amplifier-input impedance, and the apparent CMRR caused by large difference between test-point impedances. (B) Relationship of source impedance to amplifier input impedance and the apparent CMRR caused by low impedance test points.

GENERAL OPERATING INFORMATION ON THE TYPE 1A6

Function of the Front-Panel Controls

This is a brief description of the front-panel controls, input connectors and indicating lights.

VOLTS/CM — Provides 15 calibrated vertical deflection factors in 1, 2, 5 sequence from 1 mVOLT/CM to 50 VOLTS/CM and three dynamic input voltage ranges (see Fig. 2-8). All switch positions are calibrated only when the VARIABLE control is set to CAL (detent) position.

VARIABLE — Provides continuously variable uncalibrated attenuation between the calibrated deflection factors and extends the attenuation range to at least 125 volts/cm.

UNCAL — A neon lamp that lights when the VARIABLE control is out of the CAL detent position.

INPUT OVERLOAD — A neon lamp that lights when the input voltage is excessive. Approximately +50 volts, connected to either or both input connectors at deflection factors from 1 mV to 50 mV, will cause the neon to light.

POSITION — Varies the vertical position of the display.

GAIN — A screwdriver adjustment that sets the deflection factor of the amplifier to be correct at any position of the VOLTS/CM (with the VARIABLE control in CAL position).

+INPUT — Signal input connector. Positive input produces upward deflection. See Fig. 2-9.

—INPUT — Signal input connector. Positive input produces downward deflection. See Fig. 2-9.

AC-GND-DC — Two input selector switches for the + or — INPUT connectors. Switch selections are:

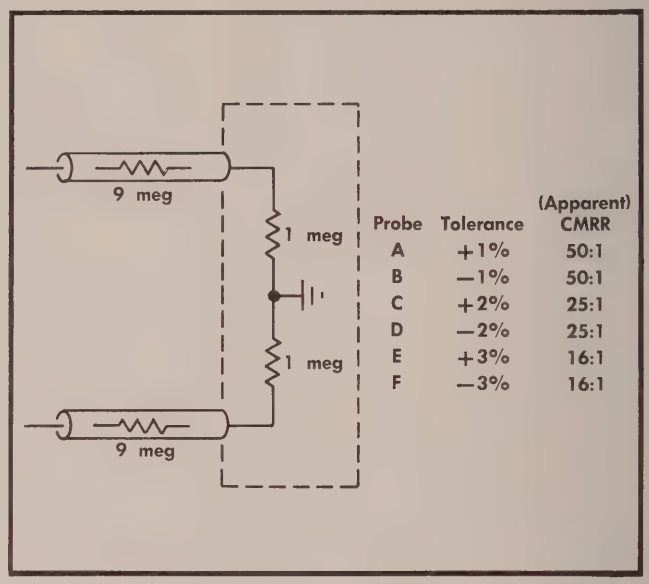
AC (The AC component of the signal is coupled to the amplifier input).

DC (Both AC and DC components are coupled to the amplifier input).

GND (Disconnects the input signal and internally grounds the input circuit. Presents the same load to the input signal and provides a charge path for the AC coupling capacitor so the capacitor will charge before switching the input to AC).

STEP ATTEN BALANCE — An adjustment that sets the DC balance of the amplifier. Adjusted for minimum trace shift as the VOLTS/CM control is switched through its range.

VARIABLE BALANCE — A control that provides fine variable DC balance. Adjusted for minimum trace shift over the full range of the VARIABLE VOLTS/CM control.



Probe	Tolerance	(Apparent) CMRR
A	+1%	50:1
B	—1%	50:1
C	+2%	25:1
D	—2%	25:1
E	+3%	16:1
F	—3%	16:1

Fig. 2-5. Simplified input circuit and table to show the change in CMRR (apparent) due to X10 probes that are within 1, 2, and 3% of their attenuation values (with matched 1 Meg resistors).

Signal Input Connections

Table 2-1 lists a number of methods for connecting to the signal source with the advantages, limitations, etc. of each to consider. Method 1 can be used to connect the instrument to a high-level low frequency signal source, if it is monitored at some low impedance point. It becomes increasingly important, however, to use shielded signal cables when any of these factors are missing. In all cases, the leads should be kept as short as possible.

When making single-ended input measurements (conventional amplifier operation) establish a common ground connection between the device under test and the Type 1A6. Normally the shield of a coaxial cable serves this purpose.

Differential measurements require no common ground connection; however, the DC plus peak AC voltages on the test point with respect to the chassis potential of the Type 1A6 should be limited to the levels listed in Section 1, under maximum common-mode input voltage characteristics. Higher signal levels will degrade the common-mode rejection ratio and exceed the input voltage rating of the unit.

Consider the signal source loading and the resulting change in the source operating characteristics due to the input circuit of the Type 1A6 and the signal cables. The

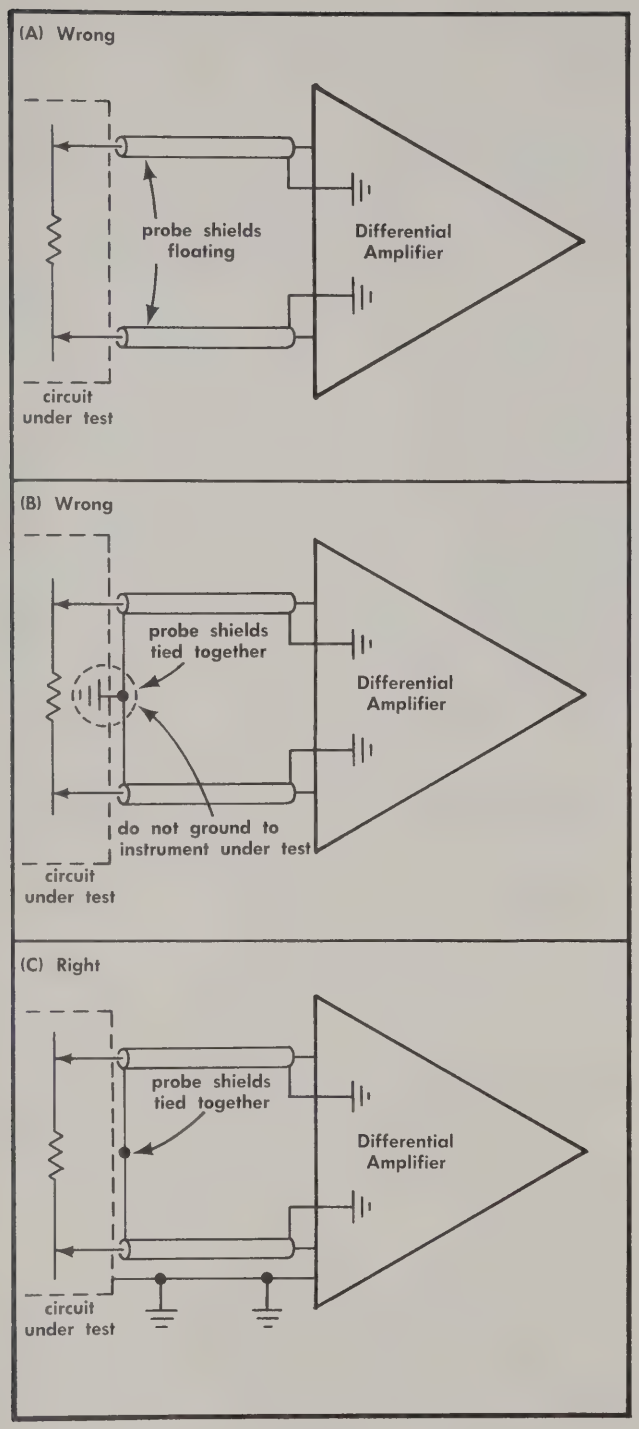


Fig. 2-6. Connecting a differential amplifier across a circuit. The ground shown in (C) is not essential to the measurement.

circuit at the input connectors can normally be represented by a 1 MΩ resistance to ground paralleled by 33 pF. A few feet of shielded cable may increase the parallel capacitance to 60 pF or more, which could be excessive in many situations. To minimize these effects, it may be advisable to use an attenuator probe.

Attenuator probes not only decrease the resistance and capacitance loading of the signal source, but also extend the measurement range of the 1A6. Attenuator probes and their effect were discussed previously in this section.

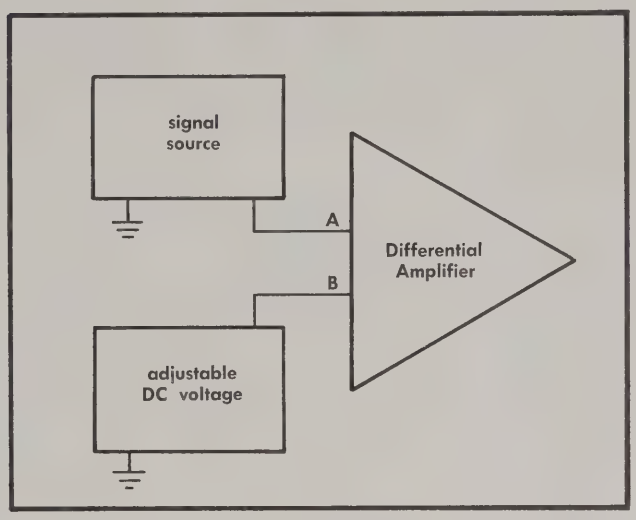


Fig. 2-7. Circuit connections for the slide-back technique described in the text.

Input Capacitor Coupling

Connecting the amplifier input to a signal voltage beyond the capacity of the amplifier will cause the trace to be deflected off the screen. This can be prevented when measuring some unknown DC voltage by the use of a higher deflection factor or lower sensitivity setting when connecting the amplifier input to the voltage source, then switching down to a higher sensitivity setting. To measure the AC component of signals containing both AC and DC components take advantage of the precharging circuit incorporated in the unit. This circuit will pre-charge the 0.1 μF coupling capacitor to the DC source voltage when the AC-GND-DC input coupling switch is set to GND position. The procedure for using this circuit is as follows:

1. Before connecting the Type 1A6 to a signal containing a DC component, set the AC-GND-DC input coupling switch to GND position, then connect the input to the circuit under test.

2. Wait a moment for the coupling capacitor to charge.

3. Set the input coupling switch to AC. The display will remain on the screen and the AC component can be measured in the usual manner.

Display Polarity

Single ended signals applied to the +INPUT connector will produce a vertical deflection in phase with the input signal. Signals applied to the —INPUT connector will be inverted.

TABLE 2-1

Signal Coupling Methods

Method of Coupling the Signal	Advantages	Limitations	Accessories Required	Source Loading	Precautions
1. Open (unshielded) test leads.	Simplicity.	Subject to stray pickup.	BNC to banana jack adapter (103-0033-00). Two test leads.	1 MΩ and 33 pF at input, plus test leads and adapter.	Use short leads. Position leads for minimum stray pickup.
2. 1×, 1 MΩ Probe.	Full sensitivity. Total Type 1A6/Oscilloscope bandwidth.	High capacitance of cable.	P6028 is 1× probe equipped with BNC connector.	1 MΩ and ≈75 pF.	High capacitance loading.
3. Unterminated coaxial cable.	Full sensitivity.	High capacitance of cable.	Coaxial cable with BNC connector(s).	1 MΩ and 33 pF plus cable capacitance.	High capacitance loading.
4. 10×, 8 MΩ Probe for P6023; 10 MΩ for others. 100×, 10 MΩ Probe. 1000×, 10 MΩ Probe.	Reduced resistive and capacitive loading, full Type 1A6/Oscilloscope bandwidth. Retain high CMRR by using two P6023 Probes for differential operation.	10× attenuation. 100× attenuation. 1000× attenuation.	P6006, P6008, and P6023 are 10×. P6007: 100×. P6015: 1000×.	P6006: ≈8 pF,10 MΩ. P6008: ≈7.5 pF, 10 MΩ. P6023: ≈12 pF, 10 MΩ. P6007: ≈2 pF, 10 MΩ. P6015: ≈2.7 pF, 100 MΩ.	Check probe frequency compensation. Use square-wave frequency less than 5 kHz, preferably 1 kHz.
5. Current transformer CT-2 and P6041 Probe. Terminated in 50 Ω at the Type 1A6. Bandwidth that of Type 1A6/Oscilloscope.	Current transformer can be permanent part of test circuit. Less than 2.2 pF to test circuit chassis. Measure signal currents in transistor circuits. Pulse current rating: 100 amps peak.	Low frequency limit: ≈1.2 kHz. RMS current rating: 2.5 amps. Deflection factor: 1 mV/mA.	Nothing extra (Perhaps additional coaxial cable for either transformer).	Insertion Z: 0.04 Ω paralleled by about 5 μH. Up to 2.2 pF capacitance loading.	Not a quick-connect device.
6. P6019 or P6020 Current Probe and Type 134 Amplifier. Bandwidth that of Type 1A6/Oscilloscope.	Measure signal currents. AC current saturation rating: 15 amps peak to peak.	Low frequency limit: ≈30 Hz. Basic deflection factor: 50 mV/mA.	None.	Insertion Z with step function applied: 0.04 Ω after 0.1 μs.	To preserve low-frequency response avoid scratching probe current transformer core.

Deflection Factor

The amount of trace deflection produced by a signal is determined by the signal amplitude, the attenuation factor of the probe, the setting of the VOLTS/CM switch and the VARIABLE control position. The calibrated deflection factors indicated by the VOLTS/CM switch apply only when the VARIABLE control is set to the CAL detent position.

The range of the VARIABLE control is at least 2.5:1 and provides uncalibrated deflection factors covering the full range between the fixed settings of the VOLTS/CM switch. The control can be set to extend the deflection factor to at least 125 volts/cm.

Differential Operation

Differential voltage measurements are made by applying the signals to both the + and — INPUT connectors. Both coupling switches should be set to the same position; AC or DC, depending on the coupling desired. A differential amplifier amplifies only the difference voltage, the common mode signal is rejected by an amount equal to the CMRR. See Fig. 2-10.

The common-mode rejection ratio (CMRR) of the Type 1A6 is greater than 10,000:1 for the 1 mV to 50 mV sensitivity range when signals from DC to 100 kHz are DC coupled to the inputs. Therefore, interfering signals that may be prevalent on single-ended measurements, such as AC line frequency hum, can be effectively rejected through differential operation. For example: analysis of a 1 mV peak-to-peak signal with a 1.0 V, 60 Hz signal variation would be impractical with single-ended operation; however, if the 60 Hz signal is common-mode to a differential input, an amplifier sensitivity of 1 mVOLT/CM would provide 1 CM of

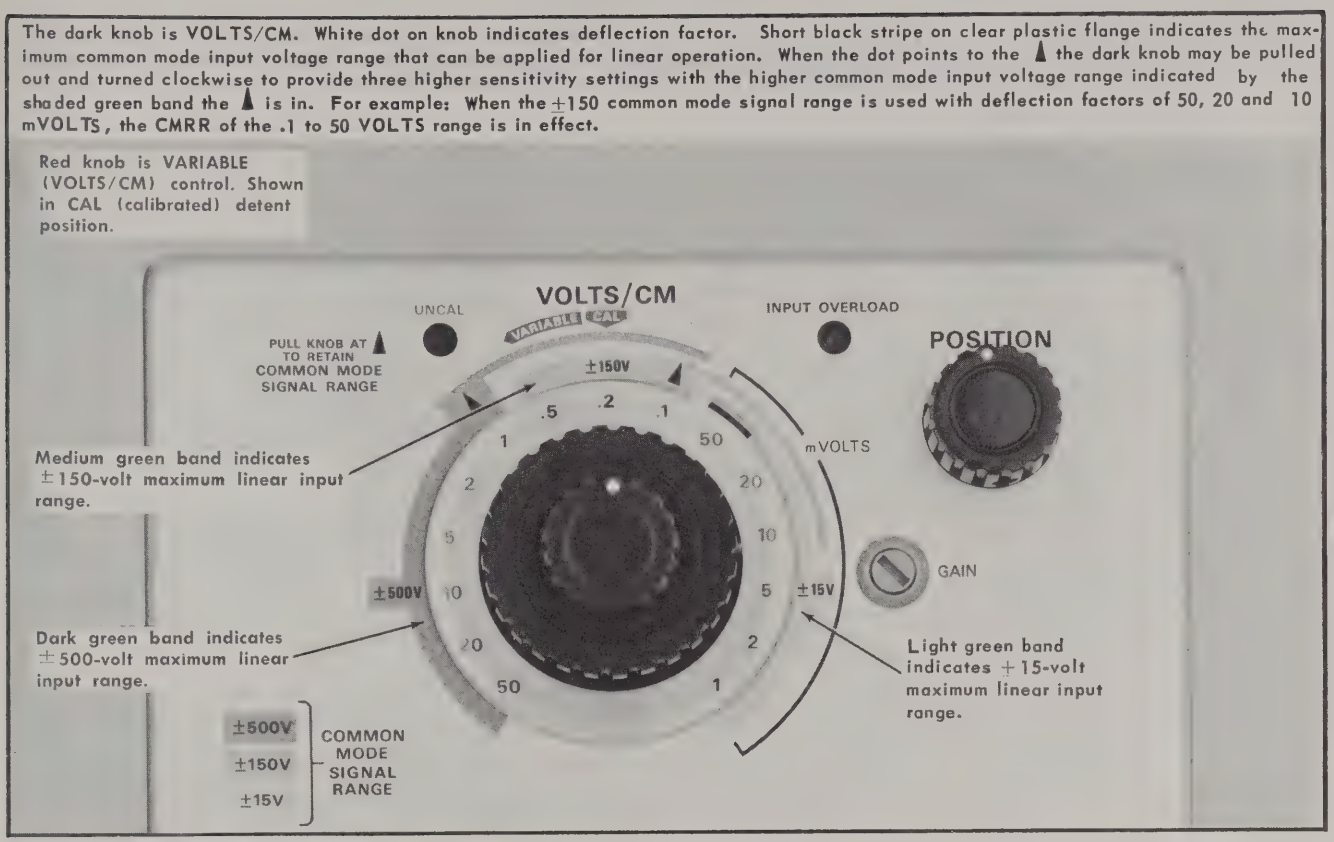

The dark knob is VOLTS/CM. White dot on knob indicates deflection factor. Short black stripe on clear plastic flange indicates the maximum common mode input voltage range that can be applied for linear operation. When the dot points to the ▲ the dark knob may be pulled out and turned clockwise to provide three higher sensitivity settings with the higher common mode input voltage range indicated by the shaded green band the ▲ is in. For example: When the ±150 common mode signal range is used with deflection factors of 50, 20 and 10 mVOLTS, the CMRR of the .1 to 50 VOLTS range is in effect.
Red knob is VARIABLE (VOLTS/CM) control. Shown in CAL (calibrated) detent position.
VOLTS/CM
UNCAL
VARIABLE CAL
INPUT OVERLOAD
POSITION
PULL KNOB AT ▲ TO RETAIN COMMON MODE SIGNAL RANGE
±150V
.5
.2
.1
1
50
mVOLTS
2
20
5
10
±500V
10
5
±15V
20
2
50
1
GAIN
Medium green band indicates ±150-volt maximum linear input range.
Dark green band indicates ±500-volt maximum linear input range.
Light green band indicates ±15-volt maximum linear input range.
±500V
±150V
±15V
COMMON MODE SIGNAL RANGE

Fig. 2-8. Function of the VOLTS/CM and input range.

desired signal modulated by less than 1/10,000 of the 1.0 volt 60 Hz signal or less than 0.1 mm of common-mode signal.

There are a number of factors which can degrade the CMRR of the Type 1A6. The P6023 probe with its adjustable R and C attenuation factors provides minimum probe reduction of the CMRR.

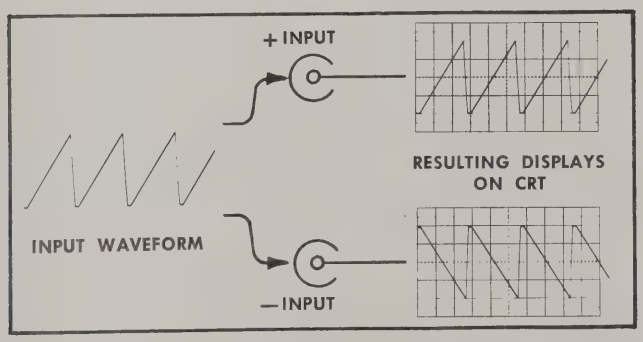


Fig. 2-9. A signal applied to the + INPUT connector produces an upright display, while a signal applied to the — INPUT connector is inverted.

P6023 Probe

The following adjustment procedure is recommended to prepare the P6023 probes for differential measurements:

1. Connect one probe for DC-coupled single-ended input operation. Obtain a triggered display of an appropriate square-wave signal such as that from the oscilloscope amplitude calibrator. Adjust the probe DC Atten Calibration control for correct deflection sensitivity; then use the AC Coarse Comp and AC Comp Fine Adjust control to compensate the probe for proper square-wave response.

2. Connect a second probe for DC-coupled operation. Apply the square-wave signal to both probes at 100 volts peak to peak. Obtain a free-running sweep and adjust the DC Atten Calibration control of the second probe for maximum low-frequency cancellation. This is indicated by the elimination of the two-trace appearance, resulting in one trace of minimum width.

3. Adjust the AC Coarse Comp and AC Comp Fine Adjust controls of the second probe to minimize the amplitude of the differentiated pulses on the trace.

4. The probes are now matched and ready for use at any sensitivity which employs the particular input attenuator used during steps 2 and 3. When a different input attenuator is used, steps 2 and 3 should be repeated. The input sensitivity group associated with each of the four attenuators is listed in Table 2-2.

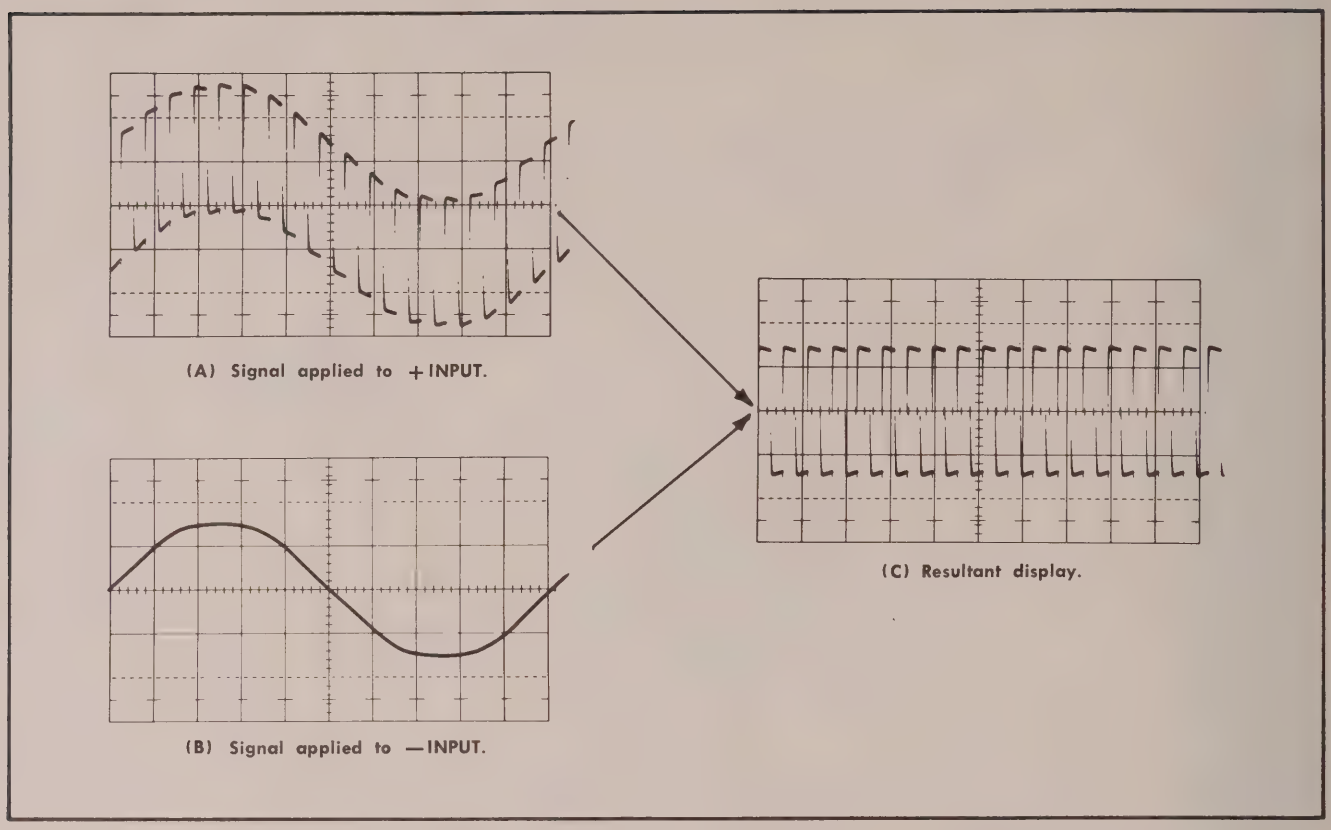


Fig. 2-10. Waveforms showing differential rejection of a common-mode signal. Resultant waveform (C) shows the difference between the two signals.

TABLE 2-2

VOLTS/CM Switch Range	Input Attenuation	
	VOLTS/CM knob in	VOLTS/CM knob pulled out
1 mV to 50 mV	1×	
10 mV to 50 mV		10×
.1 V to .5 V	10×	
.1 V to .5 V		100×
1 V to 5 V	100×	
10 V to 50 V	1000×	

INPUT OVERLOAD Light

This light turns on when a positive-going input signal is applied which is in excess of the input amplifier and front panel, balance and position capabilities. The trace or display will move off the CRT screen before the input stage saturates, therefore the OVERLOAD light is only an indication to the operator that steps must be taken to increase the input attenuation.

If the DC input voltage is in excess of 100 volts the trace will return on screen, position correctly, but have zero gain.

DC differential signals to 600 volts may be removed by using AC coupling at the input (AC-GND-DC switch in the AC position). This however, limits the low frequency response to about 2 Hz or 0.2 Hz with a 10× probe and decreases the low frequency CMRR.

SECTION 3

CIRCUIT DESCRIPTION

Introduction

This section of the manual presents a description of the Type 1A6 circuitry, keyed to the block diagram and circuit schematics in Section 9. Detailed circuit analysis includes simplified drawings of the circuit to enable the reader to readily follow signal or current paths as the description is presented.

BASIC DESCRIPTION

Signals applied to either INPUT are coupled via the input selector switch (SW1 or SW10) to the input attenuators. The attenuators for both sides are the conventional RC type, however, the —Input attenuator contains an adjustable resistance so the —Input can be matched to the +Input side and provide optimum DC CMRR.

From the input attenuators, the signals are applied to the input amplifier stage. Special constant current bootstrap circuits in this input stage, with balanced input and output, provide all of the high DC CMRR for the Type 1A6.

Differential signals from the input amplifier are DC coupled to an emitter coupled, balanced, push-pull amplifier and applied through the grounded base transistor Q164A and B to the output stage.

Gain selection for the amplifier is obtained by selecting different collector load resistance values for the grounded base amplifier.

The output stage consists of a current amplifier driving an operational amplifier. Output DC level is determined by the ratio of feedback to load resistance in the operational amplifier and is designed for about 67.5 volts.

A single control provides differential current adjustment to the base of the operational amplifier to vertically position the trace on the CRT screen.

CIRCUIT DESCRIPTION

Input Coupling and Attenuator Switching

The input selector, switches SW1 and SW10, are connected to provide AC coupling through C1 or C10; ground (GND) or DC coupling to the + and — grids of the input amplifier through the attenuator (VOLTS/CM) selector switch SW40.

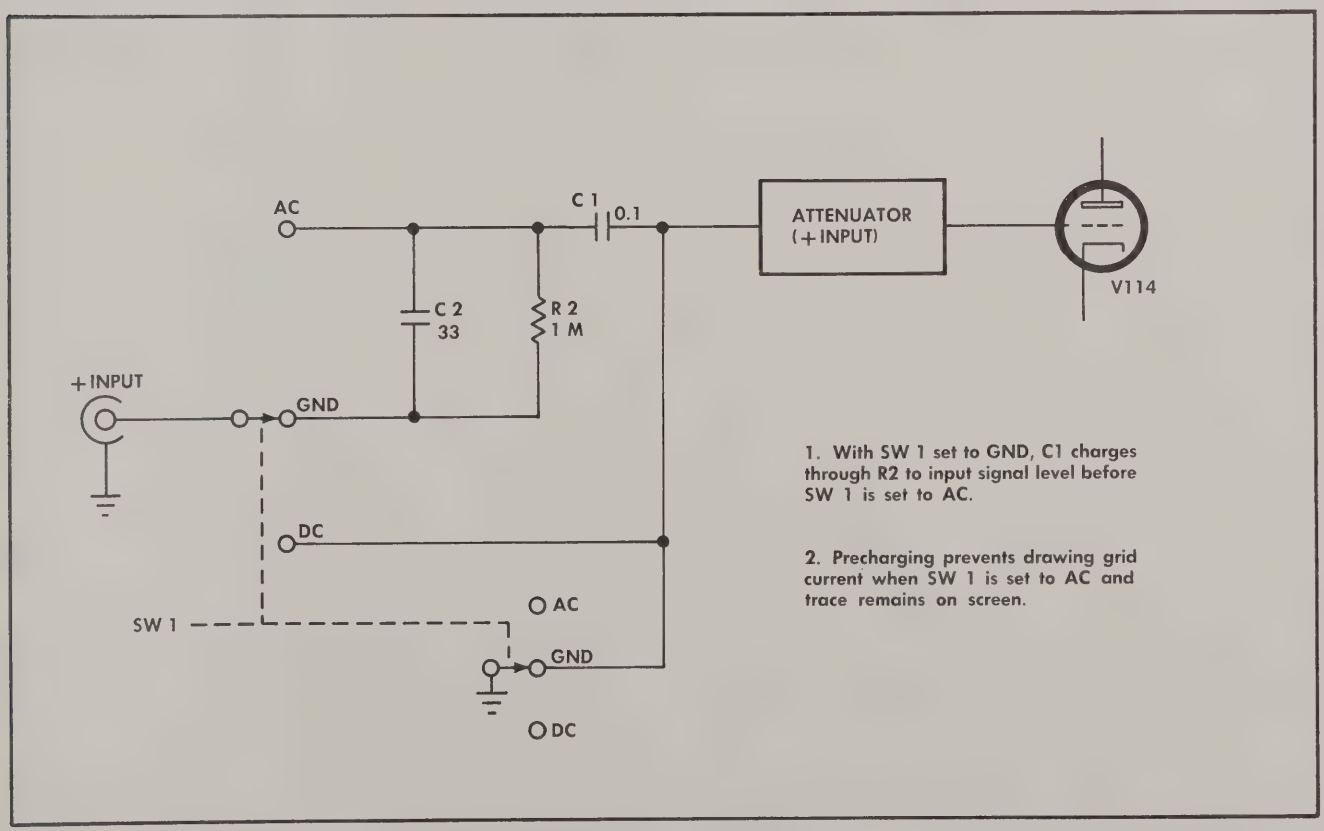


Fig. 3-1. + Input circuit showing C1 charge path.

When the +INPUT selector switch (SW1) is in the AC or DC position and the VOLTS/CM switch is in the 1× (1 to 50 mvolt) attenuator position, input R and C is established by the grid load resistor R103 and the stray circuit capacitance in parallel with C103.

Setting the +INPUT selector switch to GND position grounds the + grid and applies the input signal through R2 to charge coupling capacitor C1 to the DC or average level of the input signal. The selector switch may now be switched to the AC position and the display will remain on screen. See Fig. 3-1. Input R and C is maintained at 1 MΩ and 33 pF by R2 and C2.

NOTE

Operation of the two inputs of the Type 1A6 is symmetrical. To minimize duplication, the +input of the amplifier is described in more detail throughout the text.

Input Attenuators

Four decade attenuation factors that range from 1 to 1000 can be selected simultaneously for both the + and — inputs with the VOLTS/CM selector. These attenuators provide the following characteristics:

1. The input R and C is established at 1 MΩ and 33 pF and normalized at all settings of the VOLTS/CM switch for both input connectors. Adjustable capacitors C103 (1×), C20B (10×), C22B (100×) and C24B (1000×) provide this normalization for the +INPUT.

2. The resistive (DC or low frequency) attenuation ratios of the attenuators are equalized by adjusting R30E, R32E and R34E in each attenuator network for the —INPUT. With these adjustments accurately set, optimum common-mode rejection through the attenuators is achieved.

3. Attenuator (AC) compensation is provided by adjustable capacitors C20C, C22C and C24C for the + attenuators, and capacitors C30C, C32C and C34C for the — attenuators.

Grid emission current of the input amplifiers is balanced out by adjusting R101 and R201 for a net effective grid current of zero. This maintains a zero trace reference on the screen. See Fig. 3-2.

Three common-mode signal ranges, ±15 V, ±150 V and ±500 V, are provided when the VOLTS/CM attenuator selector is switched through its range. The ±500 or ±150 volt common-mode signal ranges may be retained through three higher sensitivity steps by pulling the VOLTS/CM selector knob at the ▲ position and then switching to any one of the next three higher sensitivity switch positions. For example; to retain ±150 V common-mode range for sensitivity ranges of 50 mV through 10 mV, pull the VOLTS/CM selector knob out when the switch is in the 0.1 Volt position, and turn the knob clockwise to any of the next three higher sensitivity positions.

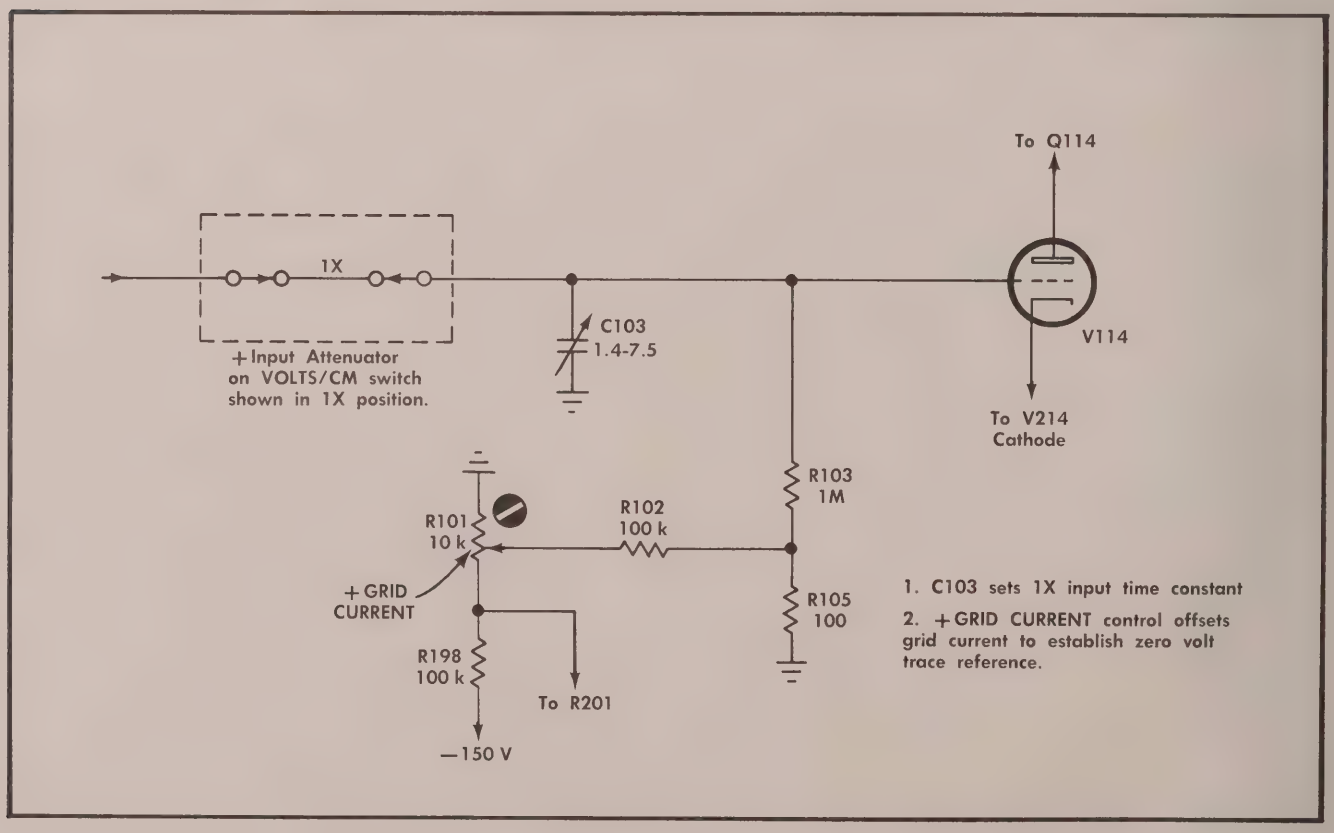


Fig. 3-2. Simplified grid circuit diagram of the + Input of the Input amplifier.

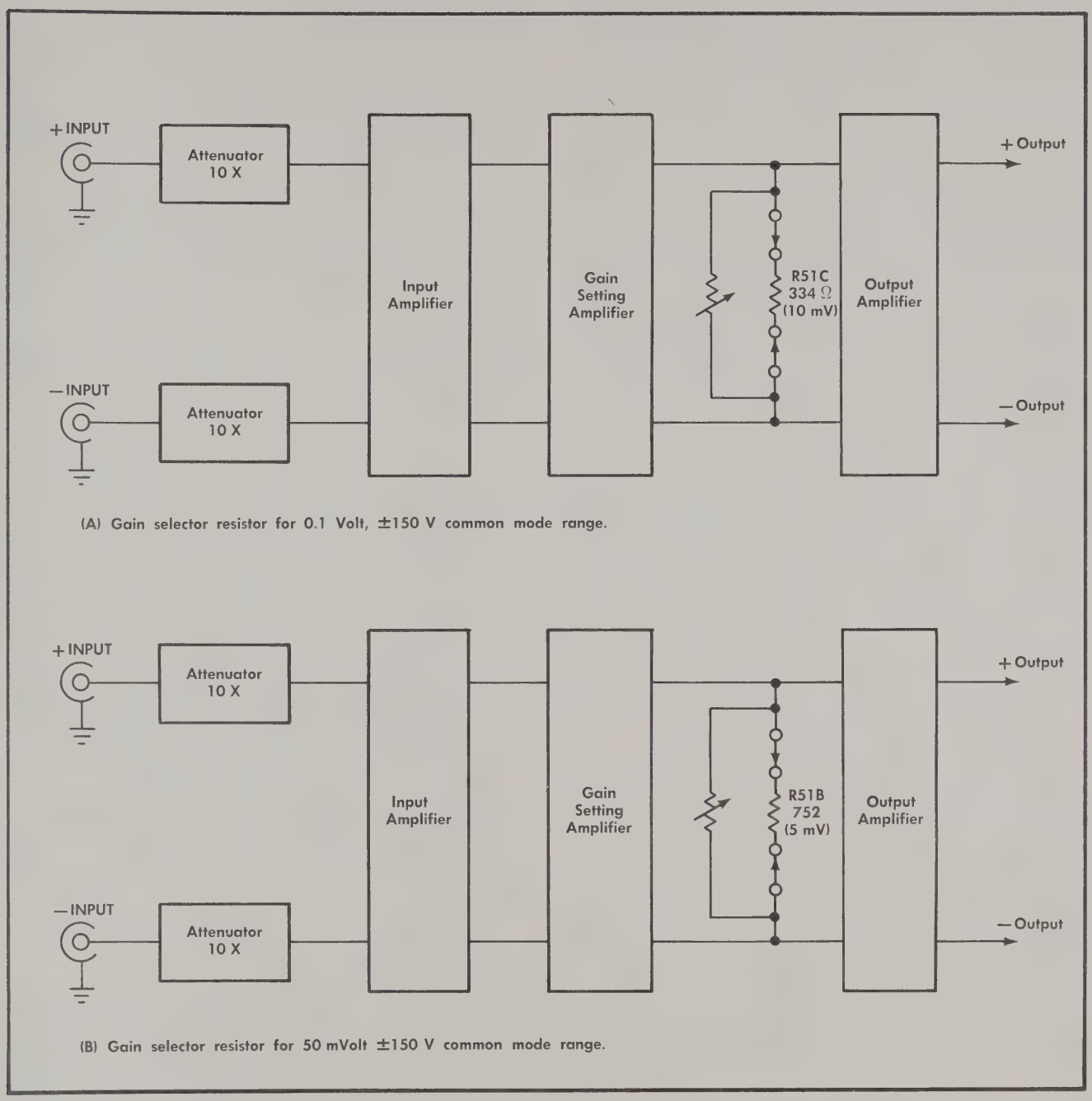


Fig. 3-3. In the ± 150 V common mode range the gain resistors may be selected to increase the gain by a factor of 2, 5 or 10 while the input attenuation remains constant.

When the VOLTS/CM selector knob is pulled out and turned to a more sensitive position, micro switch SW50 is switched from its normal position. The attenuator selector section of the VOLTS/CM switch remains in the respective 10× to 100× position and the CMRR is that of the normal attenuator position. See Fig. 3-3.

Input Amplifier

V114-Q114 and V214-Q214 are connected as a cascode paraphase or cascode differential amplifier, depending on the signal application to either one or both inputs. For true differential operation the dynamic, static and high frequency balance of the amplifier must be closely controlled. DC balance is obtained by adjusting R110 and Com Mode Bal R139.

R110 provides a differential adjustment of V114 and V214 filament voltage. This is set to equalize the tube plate currents (indirect function of cathode temperature) when the grid potentials are at zero volts. Zener diode D108 provides a regulated 12.6 volts DC for these filaments.

Com Mode Bal R139 and capacitor C136 provide differential adjustments to balance the dynamic plate impedance of the input tubes V114-V214. R139 provides DC and low frequency balance, and C136 provides the high frequency balance adjustment.

Transistor Q138 is a long-tailed (high impedance) constant current source which supplies the current for the input amplifier and a circuit that bootstraps the plate voltage of V114-V214. These features effectively minimize changes in the tube parameters as the common-mode input signal range shifts above and below an average reference.

An approximate 10 mA of source current from Q138 divides as follows: 6 mA divides to furnish a constant 3 mA per side to the input amplifier V114-V214. The fixed bias on Q128 sets a constant 2 mA through R129 to establish a fixed voltage drop across the resistor and the remaining 2 mA is absorbed by Q123. See Fig. 3-4.

Gain of the input amplifier is very stable because the constant current stabilizes the operating point on the characteristic curve of the input tube. Changes of common-mode signal at the input grids will have little effect on the CMRR of the amplifier. A positive-going shift in the average value of the common-mode signal reflects a positive shift at the common cathode point of V114-V214, and through R129 to the base of Q123. This positive voltage shift is applied to the base of Q114-Q214 by the emitter follower action of Q123 and bootstraps the plate voltage of V114-V214 to maintain a constant plate to cathode voltage (E_p). Therefore, there is no effective change in the tube parameters and current division between the tubes remains constant.

Common mode signal amplitudes (signals of equal amplitude and phase) up to ±15 volts peak at the grids produce essentially no change in the cathode current division. Input signal amplitudes in excess of ±15 volts will overdrive and unbalance the amplifier so it will no longer function as a differential amplifier. Common mode signals in excess of ±15 volts may drive the trace off screen and beyond the control of the front panel adjustments; however, at some further positive input voltage level the input amplifier saturates, the trace returns on screen and positions normally and operation appears normal. In this case, the gain will be zero. At an input signal level of approximately +50 volts the neon INPUT OVERLOAD indicator will light to indicate to the operator that an application error has been made and steps must be taken to correct the overload condition.

C140 provides a differential adjustment to equalize the load time constant of Q114-Q214 collectors and is set for optimum common mode rejection through the input amplifier as the input signal frequency is increased.

C112 and C212 provide cross neutralization of the tube inter-electrode capacitance of V114-V214. Diodes D115 and D215 limit V114-V214 grid current during the tube warmup time.

Approximately —30 volts is applied through R130 to the input amplifier chassis from the voltage divider R131-R132. Application of this negative voltage to the case of the Type 8393 tubes reduces spurious electron bombardment to the tube case.

Gain Setting Stage

Signal outputs at the collectors of Q114-Q214 are DC coupled to the base of an emitter coupled amplifier Q144A and B. Gain of the stage is determined by the emitter-to-emitter resistance of Q144 and the collector load for Q164. VARIABLE control R150, between the coupled emitters provides a gain adjustment for the amplifier.

The collector load impedance for the stage consists of the low impedance of the grounded base amplifier Q164 in parallel with R144-R244, so most of the emitter signal current of Q144A-Q144B is the collector current for Q164 and the gain becomes a function of the ratios of Q144 emitter resistance to Q164 collector resistance. The collector load impedance for Q164 is determined by R164-R264 in parallel with half of the selected gain resistors. R178 (1 mV gain adjustment) calibrates the 1 mVolt position of the VOLTS/CM selector SW40.

Step Atten Bal R155-R255 is a dual-type potentiometer with about 60° of backlash that provides both a coarse (10 kΩ) and fine (2 kΩ) adjustment. It provides a differential control of the current required to compensate and balance any DC voltage difference between the collectors of Q164A and B. When properly adjusted the voltage across the gain resistors is near zero, and DC shift on the base of Q184-Q284, as the VOLTS/CM selector is switched, is very slight.

VAR BAL is a dual potentiometer front panel control to allow the operator to seek coarse adjustment and then make a fine (backlash portion) adjustment to balance Q144 emitter-to-emitter voltages, plus compensation for unbalance due to tube aging in the input amplifier. This control supplements R110 (filament DC balance adjustment) which is an internal adjustment made when the instrument is calibrated.

Q168 sets the voltage at the collectors of Q164, the common base stage. Any fluctuations in DC current through R144-R244 which may be caused by changes in +225 volt supply, resistance values, or transistor parameters, is compensated by the addition or removal of collector current from Q168.

The emitter of Q168 is referenced to about 85 volts by a 15 V zener diode, D168. This sets the voltage on the collectors of Q164 near +82 volts.

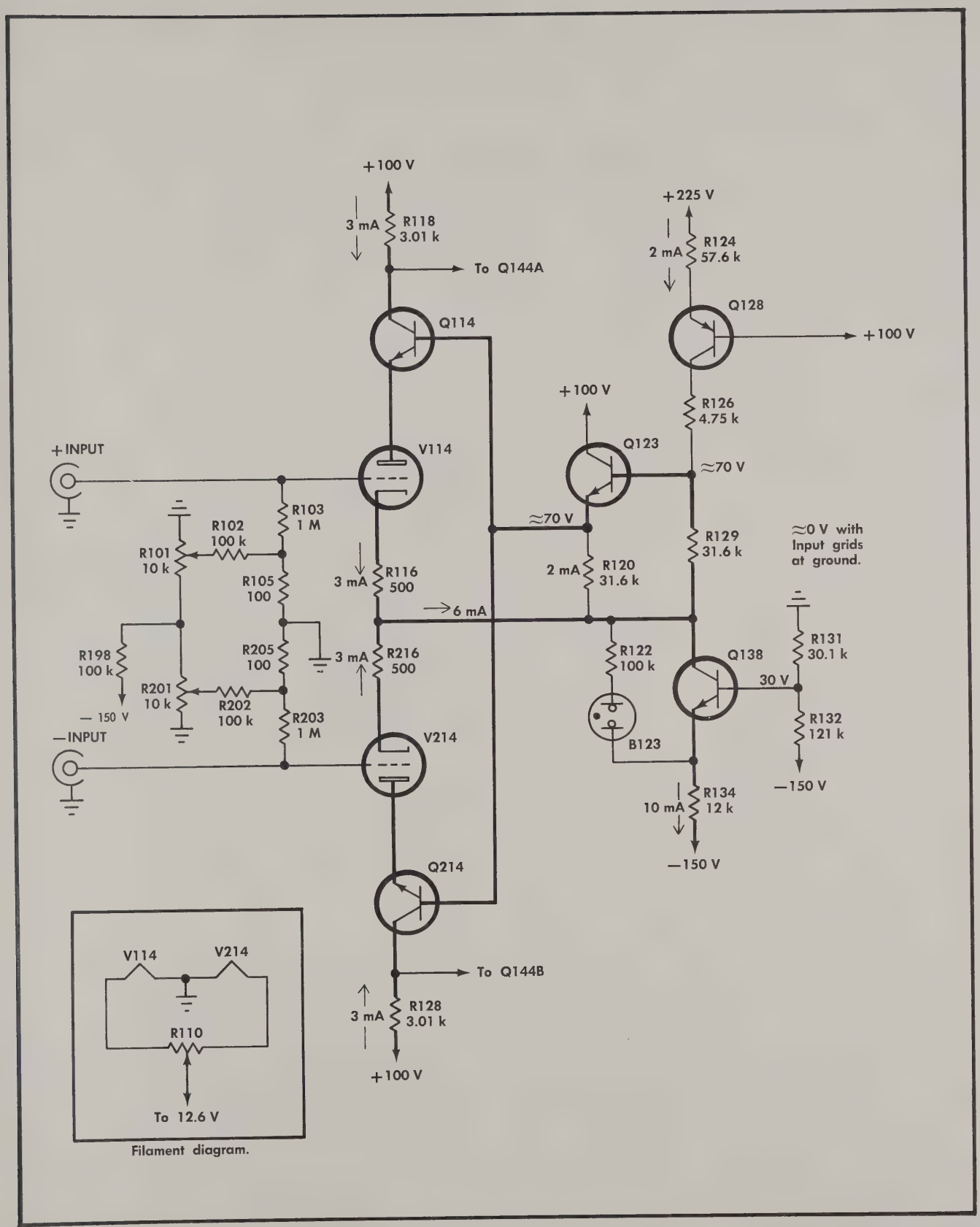
Since Q144 is a dual transistor, temperature variations of one side are transmitted to the other, so that both sides (Q144A and B) maintain thermal balance. This, with the RC thermal compensating network, R146-C146 and R246-C246, in the collector load, maintain the required thermal stability and balance for the stage.

The use of a dual transistor Q164 for the grounded base amplifier assures the required beta balance for the stage.

Output Amplifier

The amplifier output stage consists of two common emitter current amplifiers Q184-Q284 in cascode with push-pull operational amplifiers Q194-Q294.

DC output voltage level is established across R190-R290 and is a function of the ratio R180 to R190 (R280 to R290) rather than any other parameter. Positioning is determined by differential adjustment of the current to the bases of Q194-Q294 and is provided by POSITION control R184.



Filament diagram.

Fig. 3-4. Simplified (partial) diagram of the input amplifier stage with approximate current and voltage values. Heavy lines show path of bootstrap circuit.

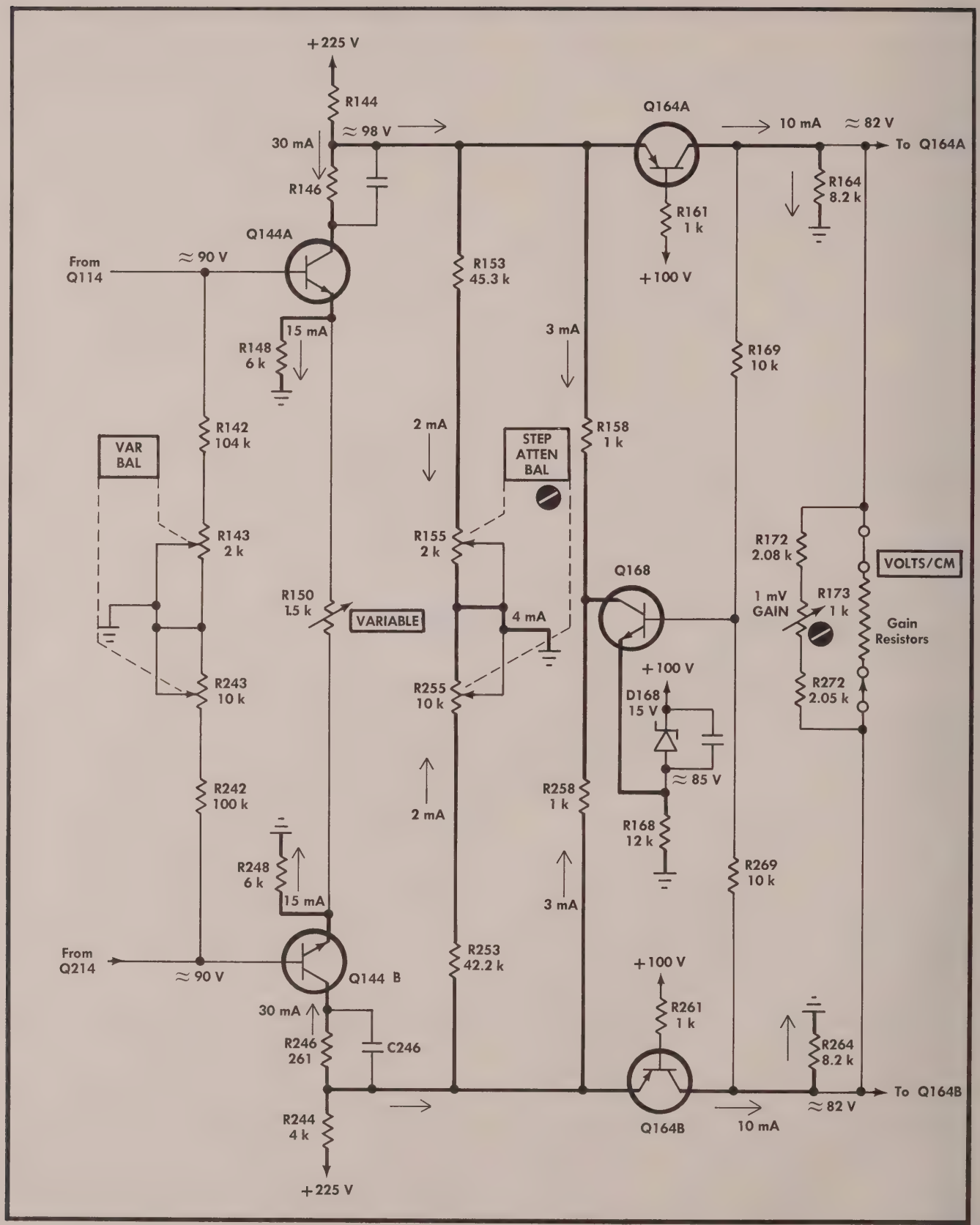


Fig. 3-5. Simplified drawing of the gain set amplifier, showing DC current and voltage levels. (All values are approximate.)

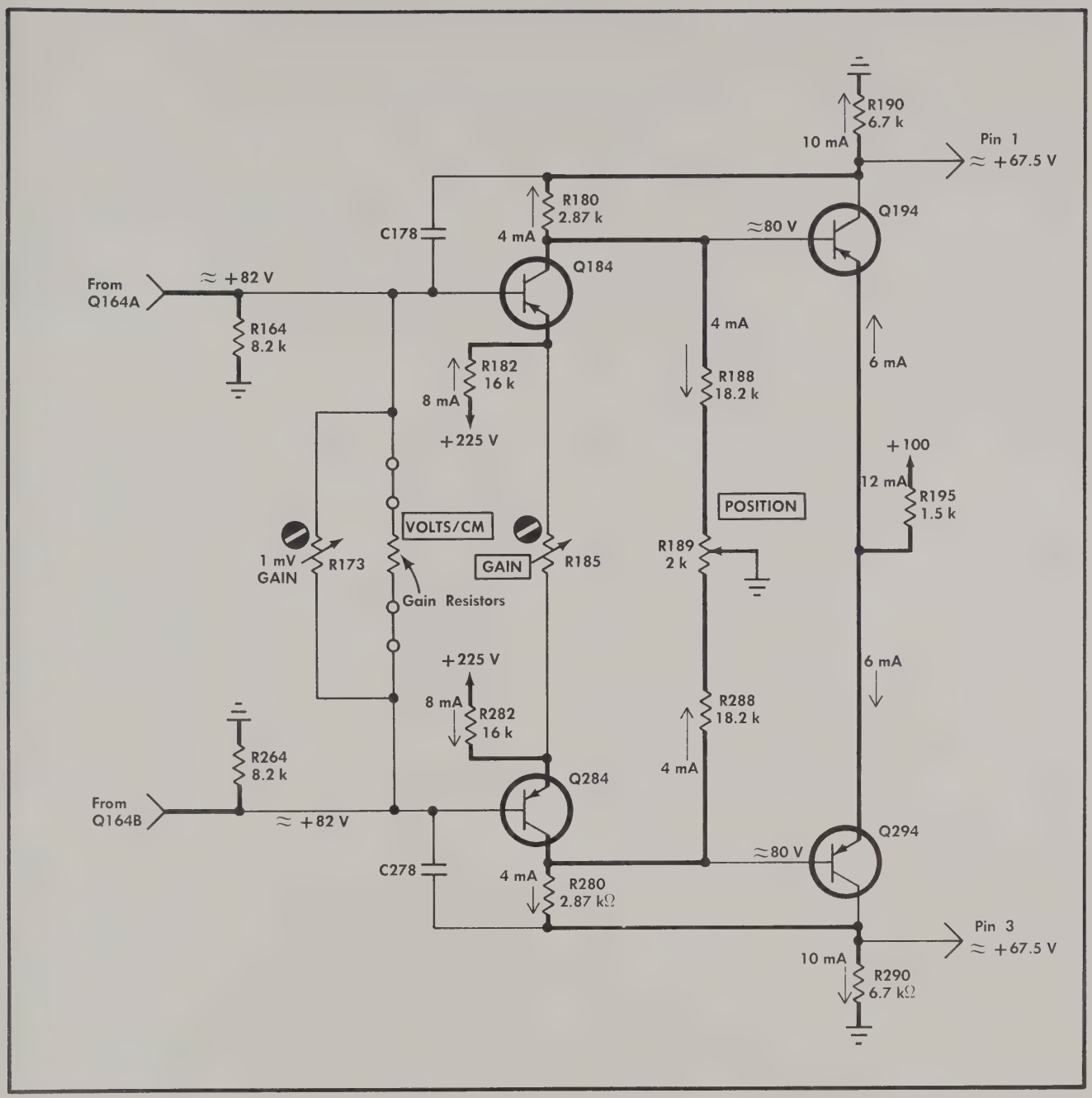


Fig. 3-6. Simplified drawing of the Output amplifier showing DC current and voltage levels. (All values are approximate.)

The fixed DC collector voltage of Q164 (about 82 V) is applied to the base of Q184 and establishes a constant DC emitter current of about 8 mA through Q184. Approximately 4 mA of this current is supplied through R188 as part of the collector current with the remaining 4 mA supplied through the feedback resistor R180. Collector current of Q194 is about 6 mA and adds to the 4 mA through R180 to provide approximately 10 mA DC current through R190 which sets the output DC voltage level of 67.5 volts. See Fig. 3-6.

AC signal currents on the base of Q184 are amplified and drive the common emitter operational amplifier Q194-Q294. This provides a balanced push-pull output to the main-frame oscilloscope amplifier.

Gain for the stage is determined by the emitter-to-emitter resistance between Q184 and Q284 and is set by adjusting the Gain control R185.

Bandwidth of the amplifier is primarily determined by the collector load of the grounded base stage and the RCL network in the collector of the input stage Q144-Q214. The amplifier bandwidth remains essentially constant throughout the sensitivity range. In the higher sensitivity positions of the VOLTS/CM selector, positive feedback through capacitors C178-C278 will boost the bandwidth of the stage so the output level is proportionate to the 50 mVOLT position.

NOTES

SECTION 4

MAINTENANCE

Preventive Maintenance

Preventive maintenance consists of cleaning, visual inspection, lubrication and if needed, recalibration. Preventive maintenance is generally more economical than corrective maintenance, since it can usually be performed during idle periods at a time convenient to the user. The preventive maintenance schedule established for the instrument should be based on the amount of use and the environment in which the instrument is used.

Cleaning

Clean the instrument often enough to prevent accumulation of dirt. Dirt on the components acts as a thermal insulating blanket (preventing efficient heat dissipation) and may provide electrical conducting paths.

Clean the instrument by loosening the accumulated dust with a dry, soft paint brush. Remove the loosened dirt by vacuum and/or dry low pressure compressed air (high-velocity air can damage certain components). Hardened dirt and grease may be removed with a cotton-tipped swab or a soft cloth dampened with water and a mild detergent solution (such as Kelite or Spray White). Abrasive cleaners should not be used.

CAUTION

Do not permit water to get inside controls or shaft bushings.

Lubrication

The life of potentiometers and selector switches is lengthened if these devices are kept properly lubricated. Use a cleaning type lubricant (such as Cramoline) on shaft bushings and switch contacts. Lubricate the switch detents with a heavier grease (Beacon grease No. 325 or equivalent). Do not over-lubricate. The necessary materials and instructions for proper lubrication of Tektronix instruments are contained in a component lubrication kit which may be ordered from Tektronix. Order Tektronix Part No. 003-0342-00.

Visual Inspection

After cleaning, the instrument should be carefully inspected for such defects as poor connections, damaged parts and improperly seated transistors. The remedy for most visible defects is obvious; however, if heat-damaged parts are discovered, determine the cause of over-heating before the damaged parts are replaced, otherwise the damage may be repeated.

Tube and Transistor Checks

Periodic preventive maintenance checks on the tubes and transistors used in the instrument are not recommended. The circuits within the instrument generally provide the most satisfactory means of checking tube or transistor operation. Performance of the circuits is thoroughly checked during recalibration so sub-standard tubes and transistors will usually be detected at that time.

Recalibration

To insure accurate measurements, the instrument calibration should be checked after each 500 hours of operation or every six months if used intermittently.

The calibration procedure can be helpful in isolating major troubles in the instrument. Moreover, minor troubles not apparent during regular operation may be revealed and corrected during calibration.

CORRECTIVE MAINTENANCE

Corrective maintenance consists of component replacement and instrument repair. Special techniques or procedures required to replace components in this instrument are described in this section.

Component Identification

The circuit number of each electrical part is shown on the circuit diagrams in Section 9 and on the pictorial diagrams of the circuit board assembly in this section. Note that a functional group of circuits (such as the amplifier) are assigned a particular series of numbers. Switch wafers are identified by counting from the first wafer located behind the detent section of the switch, towards the last wafer. The letters F and R indicate the front or rear of the wafer. For example, the designation 2R, printed near a switch section on a schematic, identifies the switch section location on the rear side of the second wafer when counting back from the detent section.

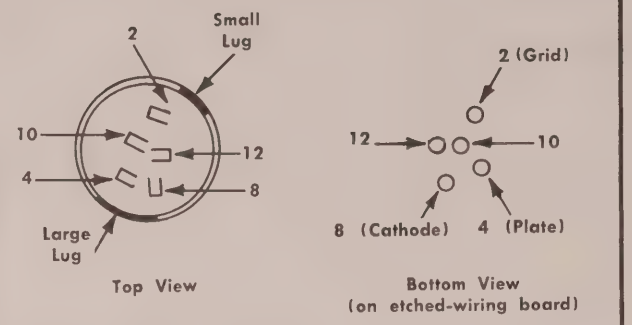
Wiring Color Code

All insulated wires used in the Type 1A6 are color-coded according to the EIA standard color code (as used for resistors) to facilitate circuit tracing. The widest color band identifies the first color of the code.

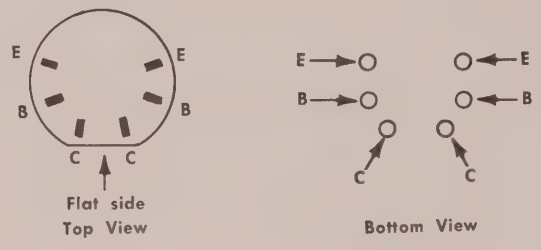
Power-supply voltages can be identified by three color bands and the following background color-code: white—positive voltage, tan—negative voltage, gray—unregulated voltage.

Resistor Color Code

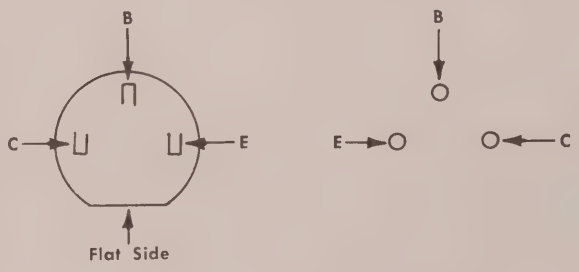
The instrument contains a number of stable metal-film resistors identified by their gray background color and color coding. If a resistor has three significant figures and a multiplier, it will be EIA color coded. If it has four significant figures and a multiplier, the value will normally be printed on the resistor. For example: a 333 kΩ resistor will



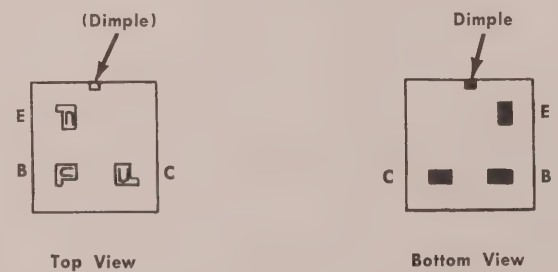
(A) Tube sockets for Type 8393.



(B) Socket for dual-type transistors. Index tab of transistor faces flat side.



(C) Socket for single-type transistor.



(D) Plastic-cased transistor sockets.

Fig. 4-1. Top and bottom views of tube and transistor sockets.

be color coded, but a 333.5 kΩ resistor will have its value printed on the resistor body. The color-coding sequence is shown in Fig. 4-2.

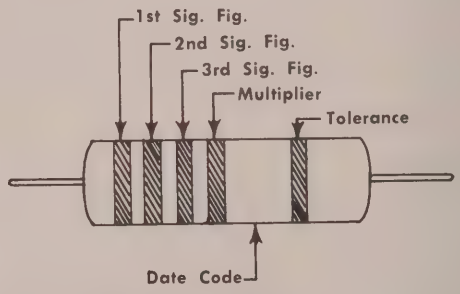
Fig. 4-3 identifies the polarity of the glass diode types used in this instrument.

Part Replacement

Most of the electronic components in the Type 1A6 are standard items available locally. The remainder of the electronic components and most of the mechanical parts are manufactured or selected by Tektronix to satisfy particular requirements, or they are manufactured for Tektronix to our specifications. However, all parts are obtainable through your Tektronix Field Office or Engineer. Before purchasing or ordering, consult the Parts List (Sections 7 and 8) and see Parts Ordering Information and Special Notes and Symbols on the page immediately preceding Section 7.

NOTE

When selecting the replacement parts, it is important to remember that the physical size and shape of the component may affect its performance in the circuit. Parts orientation and lead dress should duplicate those of the original part, since many of the components are mounted in a particular way to reduce or control stray capacitance and inductance. After repair, circuits of the instrument may require recalibration.



Color	1st Sig. Fig.	2nd Sig. Fig.	3rd Sig. Fig.	Multiplier	Tolerance (±) %
Black	0	0	0	1	—
Brown	1	1	1	10	1
Red	2	2	2	100	2
Orange	3	3	3	1,000	—
Yellow	4	4	4	10,000	—
Green	5	5	5	100,000	0.50
Blue	6	6	6	1,000,000	0.25
Violet	7	7	7	10,000,000	0.10
Gray	8	8	8	100,000,000	0.05
White	9	9	9	1,000,000,000	—
Gold				0.1	5
Silver				0.01	—
No Color					10

Fig. 4-2. Standard EIA color code for metal-film resistors.

Replacing Components on the Circuit Board Assembly

If practical, it is best to remove the circuit board assembly before replacing components. The main amplifier board in the Type 1A6 may be removed by removing the pin connectors of the electrical leads and the four mounting screws. Refer to Fig. 4-4 for wiring color code when replacing the electrical lead pin connectors.

The input amplifier board is physically mounted on the tube sockets for the input amplifier tubes. Unless the board is to be replaced, its removal is not recommended.

Use electronic grade 60/40 solder and a 15-watt pencil soldering iron with a 1/8 inch or smaller, chisel tip. The soldering iron tip should be clean and properly tinned for maximum heat transfer. Higher wattage irons may damage the bond between the etched wiring and the base material.

The following technique is suggested in the replacement of a component on the main circuit board assembly.

1. Remove the component by cutting the leads near the body. This frees the leads for individual unsoldering.

2. Grip the lead with needle-nose pliers. Apply the tip of the soldering iron to the connection at the back of the board, then pull gently to remove the lead.

3. When the lead comes out of the board it should leave a clean hole. If not, the hole should be cleaned by reheating the solder and placing a sharp object such as a toothpick or enameled wire into the hole to remove the old solder.

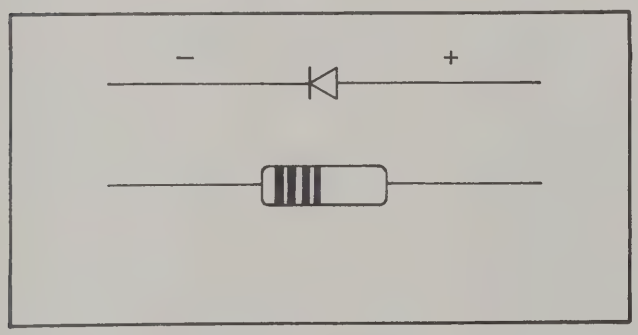


Fig. 4-3. Diode polarities and color code of glass diodes used in Type 1A6.

4. Clean the leads on the new component and bend them to the correct shape to fit into the holes. Insert the leads, making certain the component seats the same as the original part.

5. Apply the iron to the connection at the back of the board and apply only the amount of solder required to form a good electrical connection.

6. Check the front or component side of the board to insure that the solder has wicked through the plated eyelet.

NOTE

Some components can be damaged by heat. A heat sink such as a pair of needle-nose pliers or forceps between the component and the connection will protect the component from excessive heat.

7. Clip any excess leads that protrude through the hole in the board.

8. If necessary, clean the area around the soldered connection with a flux-remover solvent to maintain good environmental characteristics.

Components on the input amplifier board assembly may be removed and replaced by applying the soldering iron tip directly on the soldered eyelet at the top of the board and gently pulling the component lead until it comes loose. Bend and cut the leads of the new component to match the old and insert the leads into the eyelets. Resolder the connection, taking care to use only the amount of solder necessary to make a good electrical connection.

CAUTION

Do not apply heat on or near the two neutralizing capacitors; excess heat may warp and damage these components.

Replacing Components on Metal Terminals

When soldering metal terminals (e.g., switch terminals, potentiometers, etc.) ordinary 60/40 solder is satisfactory. The soldering iron should have a 40- to 75-watt rating and a 1/8 inch chisel tip.

1. Apply only enough heat to make the solder flow freely and form a good electrical connection. (Excess solder may impair the operation of the circuit or cover a cold solder joint.)

2. Clip off excess wire that may extend past the solder connection and clean with flux-remover solvent.

Removing and Replacing Switches

If either of the AC-GND-DC switches is defective, remove and replace the switch. Use normal care in disconnecting and reconnecting the leads. (To gain access to the AC-GND-DC switches, remove the shield.) The switches can be replaced without removing the front panel overlay. First, remove the nuts and lockwashers from the switch, then remove the switch.

Single wafers on the VOLTS/CM switch are not normally replaced. If any of these wafers are defective, the entire switch should be replaced. The switch can be ordered through your Tektronix Field Engineer, either unwired or wired, as desired. Refer to the Electrical Parts List to find the unwired or wired switch part numbers.

CAUTION

When disconnecting or connecting leads to a wafer-type switch, do not let solder flow around and beyond the rivet on the switch terminal. Excessive solder can destroy the spring tension of the contact.

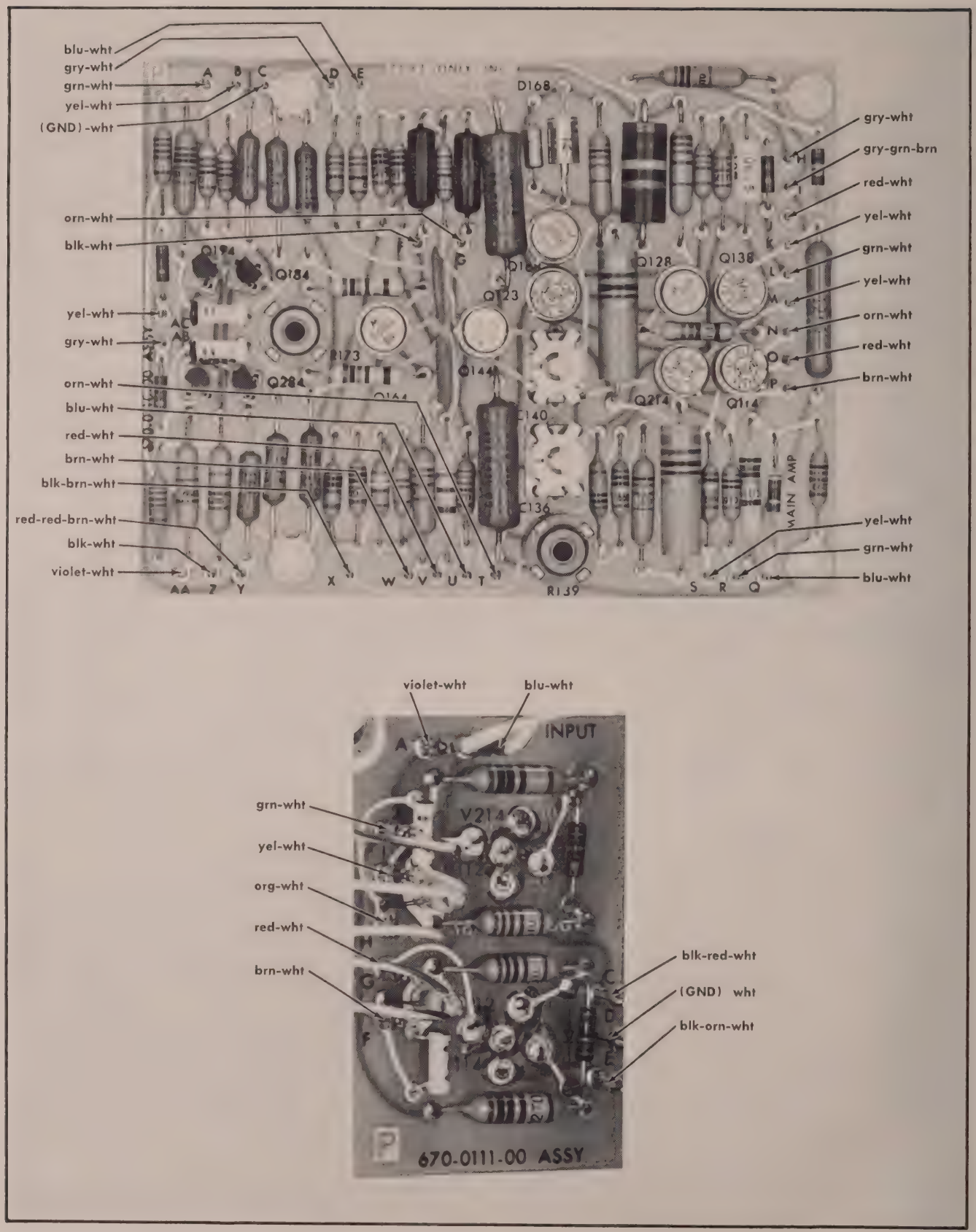


Fig. 4-4. Circuit board assembly. Wire color code to pin connectors.

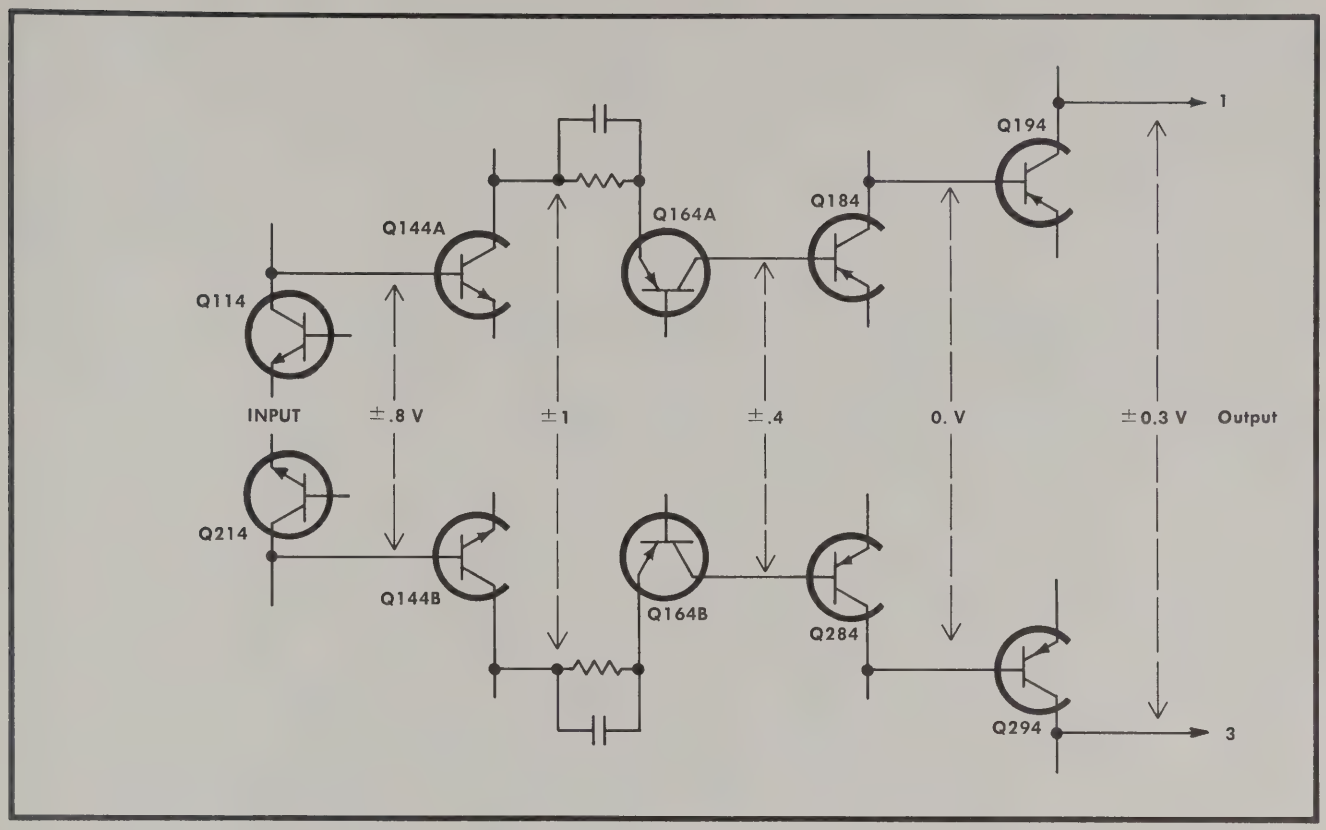


Fig. 4-5. Simplified diagram to show DC balance voltage limits at various points which, if not exceeded, should position the trace into a 6 cm high viewing area.

TROUBLESHOOTING INFORMATION

General Troubleshooting

Attempt to isolate the trouble to a circuit by operational and visual checks. Verify that the apparent trouble is actually a malfunction within the Type 1A6 and not improper control settings or a malfunction of associated equipment.

Operate the front-panel controls and note their effect on the trouble symptoms. Normal or abnormal operation of each control helps establish the nature of the trouble. Refer to Section 2 for the normal function of each control.

If the trouble cannot be isolated by front-panel checks, remove the left side panel from the main frame oscilloscope. Check voltages against those shown on the diagrams in Section 9 of the manual. Use an accurate 20,000 ohm/volt or higher DC voltmeter to measure voltages. Refer to Fig. 4-6 or 4-7 for component identification.

Start with the power-supply connections, then proceed consecutively from check point to check point. Once the trouble is isolated to a circuit, refer to the circuit description in Section 3 for a description of the normal circuit operation.

CAUTION

Use care when measuring voltages on live circuits. The small size and high density of components used in this instrument establishes a situation such that an inadvertent movement of the test probe or the use of oversized probes may short-circuit between components.

The pin connectors used to connect the circuit boards to the instrument provide a unique method of circuit isolation. For example; with the power off, DC resistance measurements can be taken.

Troubleshooting Aids

Diagrams

Block and circuit diagrams are contained in the pullout pages in Section 9. The circuit diagrams contain component circuit numbers, voltages and waveforms. Conditions under which the voltages and waveforms were taken are also indicated on the inside portion of the amplifier pullout page.

Tube and Transistor Substitution

Tubes and transistors should not be replaced unless actually defective. However, temporary substitution is often the fastest and best way to detect a defective tube or transistor.

Before substituting a tube or transistor, it is suggested that circuit conditions be checked to be certain that an exact

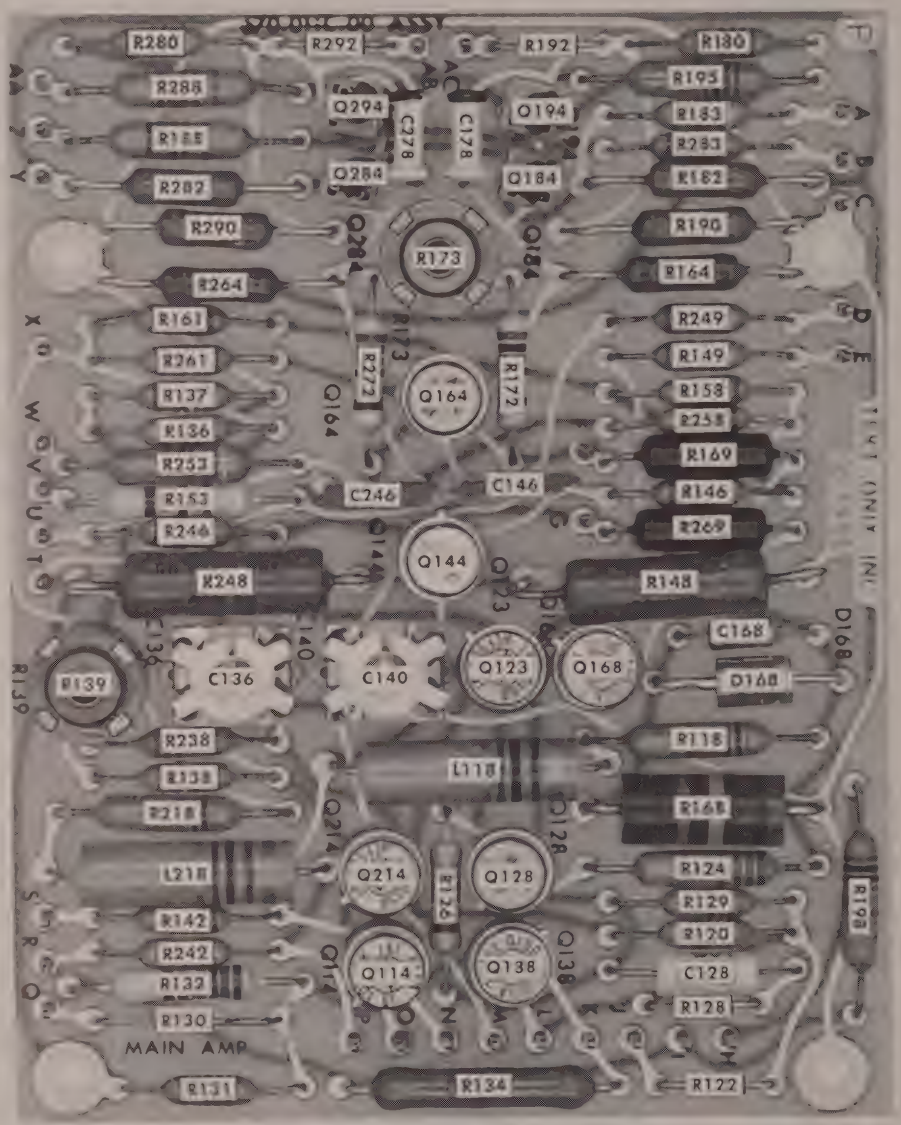


Fig. 4-6. Main amplifier circuit board assembly with component call out.

replacement tube or transistor will not be subject to damage. In some cases, these checks will also show whether or not the tube or transistor is at fault. Fig. 4-1 shows the wiring side of the tube and transistor sockets, as an aid to circuit tracing.

NOTE

Turn off the oscilloscope power before replacing tubes or transistors. When replacing Q144 or Q164, be sure the metal indexing tab faces the flat side of the socket when inserting the dual transistor into its socket. The emitter leads on these transistors are located at the opposite end from the tab (see Fig. 4-1). Nuvistor tubes V114 and V214 must be aged and matched. Tube pin diagram is shown in Fig. 4-1.

When circuit conditions have been checked, install a tube or transistor which is good and of the same type, then check for proper operation. If the original tube or transistor is thus proved operative, return it to its original socket to avoid unnecessary recalibration.

In-Circuit Diode Checks

In-circuit diode checks may be performed with a voltmeter. A comparison check of the voltages on each side of the diode with the typical voltages listed on the diagram will help determine if the diode is faulty. Forward-to-back resistance ratios can be checked by referring to the schematic and pulling appropriate tubes or transistors to remove low resistance loops around the diode.

Detailed Troubleshooting

Test Equipment

As an aid for detailed troubleshooting the following test equipment is recommended.

(1) Transistor Tester

Description: Tektronix Type 575 Transistor-Curve Tracer.

Purpose: Test semiconductors used in the Type 1A6.

(2) VOM

Description: 20,000 Ω/V DC. Be sure the test probes are suitable for measurements in high density areas without danger of accidental shorts between component leads.

Purpose: General troubleshooting.

(3) Test Oscilloscope

Description: Bandwidth, DC to 300 kHz or better. Calibrated vertical deflection factors down to 5 mV/cm with a 1× probe.

Desirable additional features: The vertical amplifier should have a differential input and a second 1× probe is needed.

Purpose: For low-frequency signal tracing in the amplifier stages.

(4) Flexible Cable Plug-In Extension

Description: 30 inches long, Tektronix Part No. 012-0038-00.

Purpose: Permits operating the Type 1A6 out of the oscilloscope plug-in compartment for better accessibility.

(5) BNC Coaxial Cables (two required)

Description: Equipped with BNC plug connectors on each end. Tektronix Part No. 012-0057-00.

Purpose: Use in low-frequency signal-tracing setup to apply the oscilloscope calibrator signal to the Type 1A6 and to the test oscilloscope Ext Trig input connector.

(6) BNC T Connector

Description: Fits one BNC jack and two BNC plugs. Tektronix Part No. 103-0030-00.

Purpose: Use in low-frequency signal-tracing setup, for connecting to the two BNC coaxial cables (item 5) and to the Cal Out connector on the oscilloscope used with the Type 1A6.

(7) Miscellaneous: Replacement tubes, transistors and diodes.

Interconnecting-Plug Resistances

Table 4-2 lists the approximate resistance measured between the interconnecting-plug pins and ground of the 16-pin plug P11, located on the rear panel of the Type 1A6. These measurements were taken with the unit disconnected from the oscilloscope.

The measurements are not absolute and may vary considerably, since semiconductors in the circuitry and different types of ohmmeters are: (1) the amount of internal voltage they use, (2) the current required to obtain full-scale deflection in each range, and (3) the meter scale readings. If ohmmeters were identical the resistance measurements given in the table would be typical.

To allow for this difference between ohmmeter types, blank columns are provided in the table for listing your own measurements. Space at the top of the columns is provided to record the type of meter used plus model number and the Type 1A6 serial number.

Isolating DC Imbalance

To make the trace appear at the center of the CRT, the DC output voltage at pins 1 and 3 of the interconnecting plug must be essentially equal. To make the trace appear within the usable viewing area of the CRT, the DC voltage measured between pins 1 and 3 must be less than ±0.3 volt, (assuming the Type 1A6 is used with an oscilloscope having 6-cm high viewing area).

The DC voltages at pins 1 and 3 of the interconnecting plug depend on the DC balance of each stage. Since all the amplifier stages are DC coupled, any excessive imbalance condition existing anywhere between input and output of the Type 1A6 can unbalance the output and cause the trace to be deflected out of the viewing area.

A procedure for isolating the cause of DC imbalance is as follows:

1. Set the Type 1A6 front-panel controls to these positions:

TABLE 4-2

Approximate Resistances at Interconnecting Plug[1]

Pin No.	Type of Meter: VOM, Triplett Model 630-PL			Type of Meter: Type 1A6 Serial No.		
	Resistance Readings		Ohms Range Used	Resistance Readings		Ohms Range Used
	+Gnd[2]	—Gnd[3]		+Gnd[2]	—Gnd[3]	
1	4.5 kΩ	5 kΩ	R × 1 k			
2	0 (Gnd)	0 (Gnd)	R × 1			
3	4.5 kΩ	5 kΩ	R × 1 k			
9	60 kΩ	35 kΩ	R × 1 k			
10	5 kΩ	5.8 kΩ	R × 1 k			
11	7.6 kΩ	10 kΩ	R × 1 k			
15	420 Ω	420 Ω	R × 10			

[1]Measured between interconnecting plug pin and ground (chassis). Pins not listed have no circuit connection (infinite resistance).

[2]Plus (+) polarity ohmmeter lead connected to chassis.

[3]Minus (—) polarity ohmmeter lead connected to chassis.

VOLTS/CM	50 mVOLTS
VARIABLE	CAL
POSITION	Midrange
AC-GND-DC (+INPUT)	GND
AC-GND-DC (—INPUT)	GND
STEP ATTEN BAL	Midrange
VARIABLE BALANCE	Midrange

2. Connect a DC voltmeter (starting from the input) between corresponding points in the amplifier as shown in Fig. 4-5 to determine the area where the imbalance originates.

For example, if the voltmeter is connected between the collectors of Q114 and Q214 and the reading is within the range indicated in the illustration, this stage is DC balanced. It also indicates that the Com Mode Bal internal adjustment is reasonably close to its proper setting.

If the voltmeter is connected between the collectors of Q164, and if the reading is greater than the voltage range given in the illustration, the DC imbalance originates in the Gain Switching stage.

3. To determine the exact cause of DC imbalance in a stage, detailed checks must be made such as: check the semiconductors in the stage, check voltages and resistances. When defective components are found and replaced, check the calibration of that portion of the circuitry.

Signal Tracing

The following method is described for checking waveform amplitude and polarity at the points shown on the amplifier diagrams. This technique is limited to the low frequencies because a flexible-cable extension is used to operate the Type 1A6 out of the oscilloscope plug-in compartment. The cable extension permits access to the Type 1A6 for detailed signal tracing and troubleshooting.

After the troubles are found and corrected, return to the Calibration Procedure in Section 6 to check frequency response and other performance requirements.

IMPORTANT

The amplitudes of waveforms shown are not absolute, but can be used as a signal-tracing guide. Waveform amplitudes may vary due to stage gain, normal manufacturing tolerances and characteristics of tubes and semiconductors.

To signal trace the stages, proceed as follows:

1. Set the front-panel controls of the Type 1A6 to the same positions as listed in the Important note located on the inside section of the amplifier schematic foldout page.

2. Connect a 30-inch plug-in cable extension between the Type 1A6 and the associated oscilloscope.

CAUTION

If the Type 1A6 is used with a Type 544, 546 or 547 Oscilloscope, be sure to pull the oscilloscope plug-in sensing switch to its outward position before turning the scope ON, to apply +75 volts to the Type 1A6 regulated heater power supply.

3. Apply a .2-volt peak-to-peak calibrator signal through coaxial cables to the Type 1A6 +INPUT connector and to the Ext Trigger Input connector of the test oscilloscope.

4. Set the test oscilloscope input coupling switch to AC and the triggering controls for +Ext triggering on the 0.2-volt calibrator signal.

5. Touch the test-oscilloscope probe tip to the coaxial cable connection at wafer 4F on the VOLTS/CM switch SW40. This is the +Input signal connection from SW1 (+INPUT, AC-GND-DC switch). Set the test oscilloscope front-panel controls so that one or two cycles of the cali-

brator waveform are displayed. Adjust the test oscilloscope triggering controls so the first ½ cycle of the waveform is positive-going. The displayed waveform on the test oscilloscope should correspond to the input waveform polarity shown at the +INPUT connector on the Attenuator Switching schematic. Disconnect the probe.

6. Touch the probe tip to the desired test point in the Type 1A6 circuitry. Select a point where a waveform is shown on the schematic. Set the test oscilloscope vertical deflection factor to correspond to the setting at the left side of the waveform shown on the schematic.

7. Check the displayed waveform polarity and amplitude, then disconnect the probe.

8. Continue to the next test point until an abnormal indication is definitely obtained. Proceed next with detailed troubleshooting checks in that stage to find the cause of the trouble. Such checks usually consist of signal-tracing between circuit points, semiconductor or tube substitution, voltage and resistance checks, etc. Refer to Section 3, Circuit Description, for analysis of the circuit.

CAUTION

Use care when measuring voltages on live circuits. The small size and high density of components used in this instrument establishes a situation such that an inadvertent movement of the test probe or the use of oversized probes may short-circuit between components.

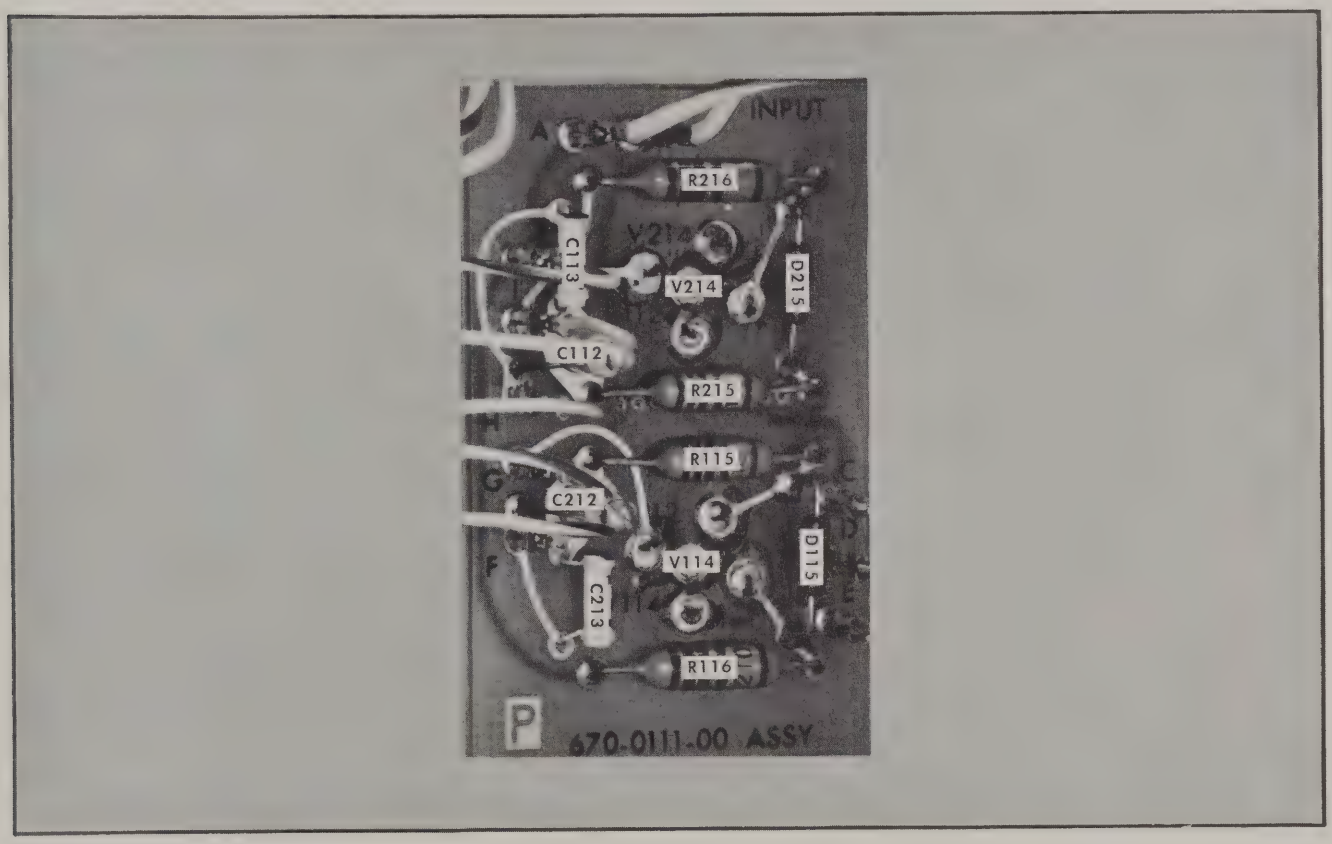


Fig. 4-7. Circuit board assembly of the input amplifier showing component identification.

NOTES

SECTION 5

PERFORMANCE CHECK

Introduction

This section of the manual provides a means of rapidly checking the performance of the Type 1A6. It is intended to check the calibration of the instrument without the need for performing the complete Calibration Procedure. The Performance Check does not provide for the adjustment of any internal controls. Failure to meet the requirements given in this procedure indicates the need for internal checks or adjustments, and the user should refer to the Calibration Procedure in this manual.

Recommended Equipment

The following equipment is recommended for a complete performance check. Specifications given are the minimum necessary to perform this procedure. All equipment is assumed to be calibrated and operating within its original specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

For accuracy and convenience, special calibration fixtures are used in this procedure. These calibration fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Tektronix 530-, 540-, 550, or 580[1] Series Oscilloscope. Type 545B is used in this procedure.

2. Square-Wave Generator: Frequency 450 Hz to 1 MHz, risetime $\leq$15 ns. Tektronix Type 106.

3. Standard Amplitude Calibrator: Accuracy within 0.25% amplitude range 100 mV to 100 V in calibrated steps, frequency approximately 1 kHz. Tektronix Calibration Fixture 067-0502-00.

4. Constant Amplitude Signal Generator with a 5 ns GR cable: Frequency range—50 kHz to >2 MHz, output amplitude variable and accurate to within $\pm$3% from 50 kHz to 2 MHz. Tektronix Type 191 Constant Amplitude Signal Generator.

5. Sine-Wave Generator: Output frequency range—60 Hz to 100 kHz, output amplitude range $\leq$2 V to 30 V peak to peak.

6. Input RC Normalizer: RC = 1 MΩ × 33 pF, equipped with BNC connectors. Tektronix Type No. 067-0540-00.

7. Termination—50 Ω with BNC connectors. Tektronix Part No. 011-0049-00.

8. Adapter—GR to BNC male. Tektronix Part No. 017-0064-00.

9. T connector—BNC connectors. Tektronix Part No. 103-0030-00.

10. Dual-Input Connector—BNC connectors. Provides matched signal paths to both inputs of the Type 1A6. Tektronix Part No. 067-0525-00.

11. Two coaxial cables—50 Ω impedance, 45 inches long with BNC connectors. Tektronix Part No. 012-0057-00.

12. Patch cord: BNC to banana plug, length 18 inches. Tektronix Part No. 012-0090-00.

[1]**Type 81 Plug-In Adapter is required with the Type 580 Series oscilloscope.**

PERFORMANCE CHECK PROCEDURE

In the following procedure, test equipment connections and setups should be changed only when noted. If a partial check is to be performed, refer to the previous step(s) for setup information.

This procedure is based on the list of recommended equipment. If substitute equipment is used, control settings and setup must be altered to meet the requirements of the equipment used.

Preliminary Procedure

1. Install the Type 1A6 into the oscilloscope plug-in compartment and connect the oscilloscope to a line voltage source within the regulating range of the scope power supplies.

2. Apply power to the required test equipment and turn on, to allow the test equipment to stabilize.

3. Preset the front panel controls as follows, turn the power on and allow 30 minutes warm-up time for the 1A6 to stabilize.

4. Set the controls as follows:

Type 1A6

VOLTS/CM	10 mVOLTS
VARIABLE	CAL
POSITION	So trace coincides with graticule center
VARIABLE BALANCE	Midrange
AC-GND-DC (+INPUT)	GND
AC-GND-DC (—INPUT)	GND

Indicator Oscilloscope

Time/Cm	.5 mSEC
Variable	CALIBRATED
Triggering Controls	Adjusted for a free running sweep
Stability	cw
Source	Internal (Normal)
Coupling	AC
Slope	—
Horizontal Display	Normal or A
Amplitude Calibrator	Off

1. Check Attenuator Balance

a. Requirement—Must have sufficient range to balance the gain attenuator through the 50 mVOLTS to 1 mVOLTS positions.

b. Adjust the STEP ATTEN BALANCE for minimum trace shift as the VOLTS/CM selector is switched through the 50 mVOLTS to 1 mVOLTS position.

2. Check Variable Balance

a. Requirement—Must have sufficient range to balance the trace shift due to rotation of the VARIABLE control with the VOLTS/CM selector at 10 mVOLTS position.

b. Set the VOLTS/CM selector to 20 mVOLTS position, then adjust the VARIABLE BALANCE control for minimum trace shift as the VARIABLE attenuation control is rotated through its range. Increase the sensitivity setting of the VOLTS/CM switch progressively to the 2 mVOLTS position, readjusting the VARIABLE BALANCE at each VOLTS/CM setting.

3. Check Microphonics

a. Requirement—DC shift or prolonged ringing is typically less than 1 cm.

b. Set the VOLTS/CM switch to 1 mVOLTS position. Lightly tap the front panel of the Type 1A6 with the fingers and note the amount of trace shift and ringing.

4. Check Gain at 50 mVOLTS/CM and Variable Control Attenuator Range

a. Requirement—Gain control must have sufficient range to calibrate 50 mVOLTS position of the VOLTS/CM switch. The VARIABLE control must attenuate the displayed input signal by a factor of 2.5:1 or more.

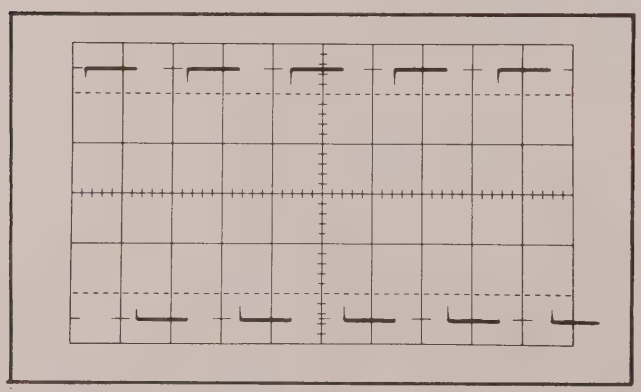


Fig. 5-1. Typical CRT display showing correct vertical gain at 1. mV/cm.

b. Apply a 0.2-volt signal from the Standard Amplitude Calibrator to the +INPUT connector. Set the Type 1A6 VOLTS/CM switch to 50 mVOLTS and the VARIABLE control to CAL detent.

c. Set the +INPUT selector switch to DC position and adjust the GAIN control for a display amplitude of exactly 4 cm.

d. Set the Standard Amplitude Calibrator for a 5-mVOLT output signal and set the VOLTS/CM switch to 1 mVOLTS position.

e. Check—Display amplitude must equal 5 cm ±0.75 mm. See Fig. 5-1.

f. Rotate the VARIABLE control fully counterclockwise.

g. Check—Display amplitude is 2 cm or less (attenuation ratio 2.5:1 or more) and the UNCAL neon indicator is lit. See Fig. 5-2.

h. Return the VARIABLE control to the CAL position.

5. Check AC-GND-DC Input Switch

a. Requirement—Input coupling is as indicated.

b. With the Input selector switch in the GND position, center the trace vertically.

c. Set the VOLTS/CM switch to 50 mVOLTS and the +Input selector switch to DC.

d. Apply 0.1 V signal from the Standard Amplitude Calibrator to the +INPUT connector. Check for a positive-going (upward) signal of 2 cm above the graticule center horizontal line.

e. Change the +Input selector to AC position and check for a 2 cm display center about the graticule center horizontal line.

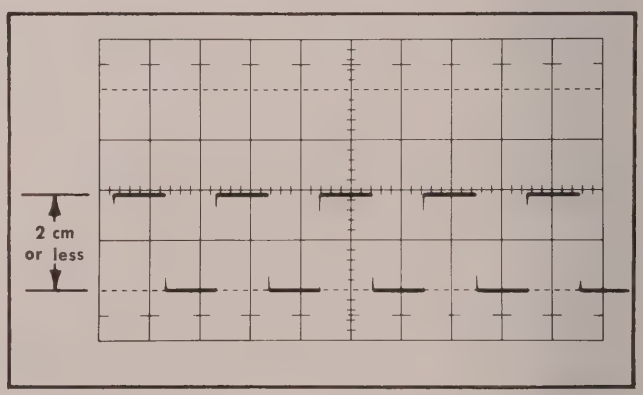


Fig. 5-2. Checking the VARIABLE control 2.5:1 ratio. This display is within the 2-cm maximum amplitude requirement.

f. Remove the Standard Amplitude Calibrator signal from the +INPUT connector and apply the signal to the —INPUT connector.

g. Set the +Input selector to GND position, then check the operation of the —Input selector switch using the same procedure as the check on the +Input selector switch. Signal should deflect downward from the graticule center horizontal line with the —Input selector switch in the DC position.

6. Check Amount of Trace Shift Due to Input Grid Current

a. Requirement—With the INPUT connector terminated in 50 Ω the amount of trace shift due to grid current should not exceed 1 cm at 1 mV/cm.

b. Set the Type 1A6 VOLTS/CM switch to 1 mVOLTS and connect a 50-Ω termination to the +INPUT connector. Set both Input selector switches to GND.

c. Position the trace to the graticule center horizontal line for reference.

d. Switch the +Input selector switch to AC position.

e. Check—Trace shift should not exceed 1 cm.

f. Remove the 50-Ω termination from the +INPUT connector and connect it to the —INPUT connector. Return the +Input selector switch to GND position.

g. Position the trace to the graticule center horizontal line.

h. Switch the —Input selector switch to the AC position.

i. Check—Trace shift should not exceed 1 cm.

j. Remove the 50-Ω termination and set both Input selector switches to GND position.

7. Check Input Overload Neon Operation

a. Requirement—Neon lights when an input voltage ≥+50 volts is applied to either or both inputs, and extinguishes with ≤+20 volts, with no internal or external attenuation.

b. Set the VOLTS/CM switch to 50 mVOLTS position and both input selector switches to GND.

c. Apply the output of the Standard Amplitude Calibrator through a coaxial cable and dual input connector to both INPUT connectors of the Type 1A6.

d. Set the +Input selector switch to DC and increase the output of the Standard Amplitude Calibrator to 50 volts.

e. Check—INPUT OVERLOAD neon should light.

f. Decrease the Standard Amplitude Calibrator output to 20 volts.

g. Check—INPUT OVERLOAD neon should extinguish.

h. Repeat this check for the —Input, then set both Input selector switches to DC position.

i. Repeat check of the INPUT OVERLOAD operation with voltage applied to both inputs.

8. Check Cross Neutralization

a. Requirement—≤3% waveform deviation.

b. Remove the dual input connector and apply the output of the Standard Amplitude Calibrator to the +INPUT connector. Set the calibrator for 50 mV signal output.

c. Set the Type 1A6 VOLTS/CM switch to 10 mVOLTS and the +Input selector switch to DC.

d. Adjust the oscilloscope triggering controls for a stable display and center the display within the graticule area. Note waveform amplitude and shape.

e. Switch the —Input selector switch from GND to DC position.

f. Check—Waveform deviation from that observed in step d, at the upper leading corner of the waveform. Deviation should be no greater than ±3% (±1.5 mm for a 5 cm waveform). Similar to Fig. 5-3, except that the upper corner is the point at which the check is made.

g. Disconnect the Standard Amplitude Signal from the +INPUT and apply the signal to the —INPUT connector.

h. Check—Deviation of the lower leading corner of the waveform. See Fig. 5-3.

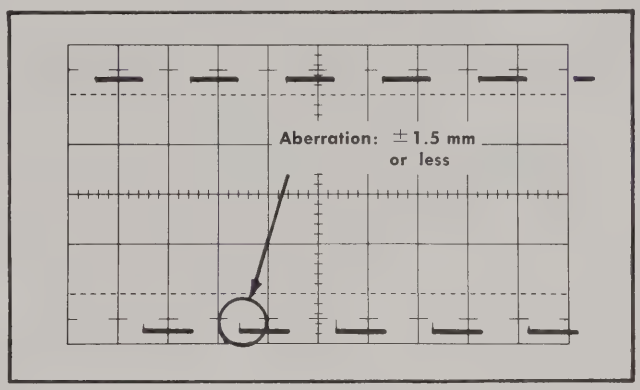


Fig. 5-3. Typical display obtained when checking cross neutralization.

9. Check VOLTS/CM Attenuator Accuracy

a. Requirement—Vertical deflection within ±1.5% of indicated deflection sensitivity from 1 mVOLT to 50 mVOLT range and ±2.5% of indicated setting from .1 VOLTS to 50 VOLTS.

TABLE 5-1

VOLTS/CM Position	Standard Amplitude Calibrator Output	Vertical Signal Amplitude
1 mVOLTS	5 mVolt	5 cm, ±0.75 mm
2 mVOLTS	10 mVolt	5 cm, ±0.75 mm
5 mVOLTS	20 mVolt	4 cm, ±0.6 mm
10 mVOLTS	50 mVolt	5 cm, ±0.75 mm
20 mVOLTS	.1 Volt	5 cm, ±0.75 mm
50 mVOLTS	.2 Volt	Adjusted in step 4c
.1 VOLTS	.5 Volt	5 cm, ±1.25 mm
.2 VOLTS	1 Volt	5 cm, ±1.25 mm
.5 VOLTS	2 Volt	4 cm, ±1.0 mm
1 VOLTS	5 Volt	5 cm, ±1.25 mm
2 VOLTS	10 Volt	5 cm, ±1.25 mm
5 VOLTS	20 Volt	4 cm, ±1.0 mm
10 VOLTS	50 Volt	5 cm, ±1.25 mm
20 VOLTS	100 Volt	5 cm, ±1.25 mm
50 VOLTS	100 Volt	2 cm, ±0.5 mm

b. Apply the output signal of the Standard Amplitude Calibrator to the +INPUT connector and check each position of the attenuator as per Table 5-1. Set the VARIABLE control in the CAL position.

10. Check Input Attenuator Compensation

a. Requirement—Maximum overshoot, rounding, ringing or tilt of a square wave is ±2%.

b. Apply 1 kHz output square wave from the Square-Wave Generator through 33 pF ×1 MΩ Input RC Normalizer to the INPUT connector designated in Table 5-2. Adjust the output amplitude control to maintain 5 cm display amplitude for each position of the VOLTS/CM selector.

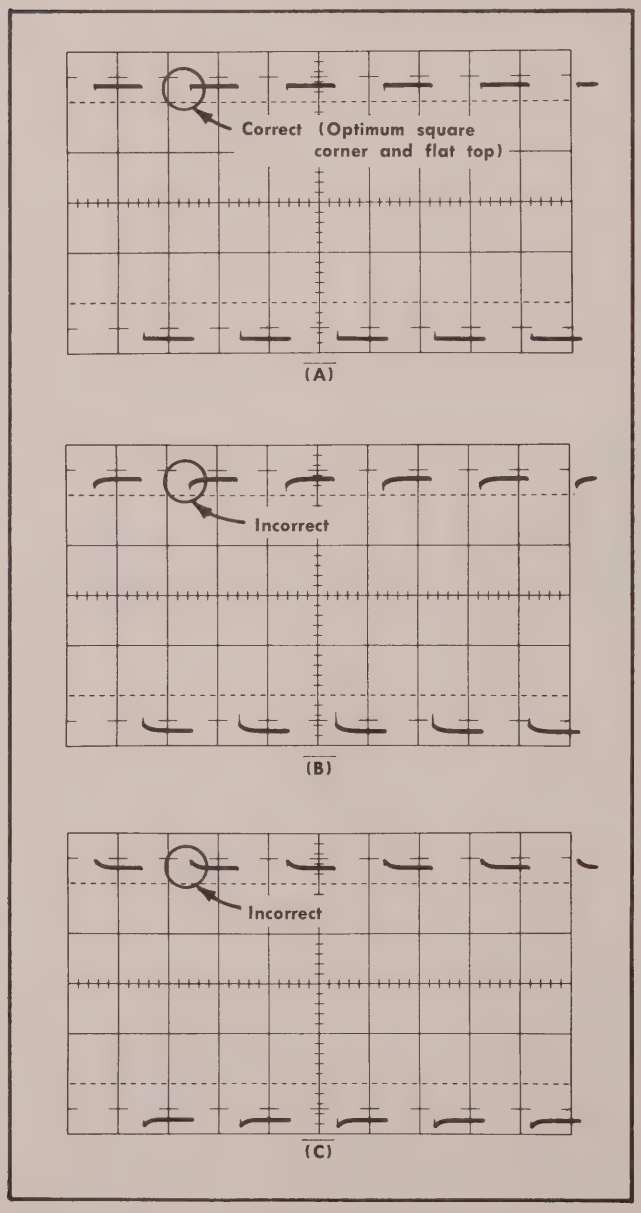


Fig. 5-4. (A) Typical CRT display showing correct input attenuator compensation. (B) and (C) show incorrect compensation.

c. Check—Transient response of the input attenuator. See Fig. 5-4.

TABLE 5-2

Input connector for signal application	+Input switch position	—Input switch position	VOLTS/CM switch position	Transient response ≤2% aberration
—INPUT	GND	DC	.1 VOLT	≤±1.0 mm
+INPUT	DC	GND	.1 VOLT	≤±1.0 mm
+INPUT	DC	GND	1 VOLT	≤±1.0 mm
—INPUT	GND	DC	1 VOLT	≤±1.0 mm
—INPUT	GND	DC	10 VOLT	≤±1.0 mm
+INPUT	DC	GND	10 VOLT	≤±1.0 mm

d. Disconnect the Input RC Normalizer and signal from the square-wave generator to the Type 1A6 input.

11. Check DC Common Mode Balance

a. Requirement — ≥10,000:1 (1 mV/Cm to 50 mV/Cm) when a DC to 100 kHz signal, up to 15 V in amplitude, either positive or negative, is DC coupled to the Type 1A6.

b. Apply the output of a Sine-Wave Generator through a coaxial cable, a T connector and a dual input connector to the two INPUT connectors on the Type 1A6.

c. Set the —Input selector switch to GND and the +Input selector to DC position. Set the frequency of the sine-wave generator to 1 kHz and adjust its output for a 30 V peak to peak signal (3 cm amplitude with the VOLTS/CM switch in the 10 VOLT position and the VARIABLE control in the CAL position).

d. Connect a patch cord from the T connector to the oscilloscope Ext Horiz Input connector, switch the HORIZONTAL DISPLAY switch to Ext Horiz 10× position. Switch both Type 1A6 Input selector switches to GND position and adjust the oscilloscope VARIABLE 1-10 control for a horizontal deflection of 10 cm. See Fig. 5-5.

e. Change the VOLTS/CM selector to 1 mVOLTS position and set both Input selector switches to DC position.

f. Check—Vertical deflection of the X-Y display should not exceed 3 cm.

12. Check CMRR at 60 Hz AC Coupled

a. Requirement—≥2000:1 (1 mV/Cm to 50 mV/Cm) when a 60 Hz, 30 V peak-to-peak sine-wave signal is AC coupled to the Type 1A6.

b. Set the Sine-Wave Generator frequency to 60 Hz and adjust its output to 30 volts peak to peak using the procedure in step 11b through 11d.

c. Set the Type 1A6 VOLTS/CM switch to 10 mVOLTS and both Input selector switches to AC position.

d. Check the vertical deflection of the X-Y display. Must not exceed 1.5 cm (CMRR = 2,000:1 or higher).

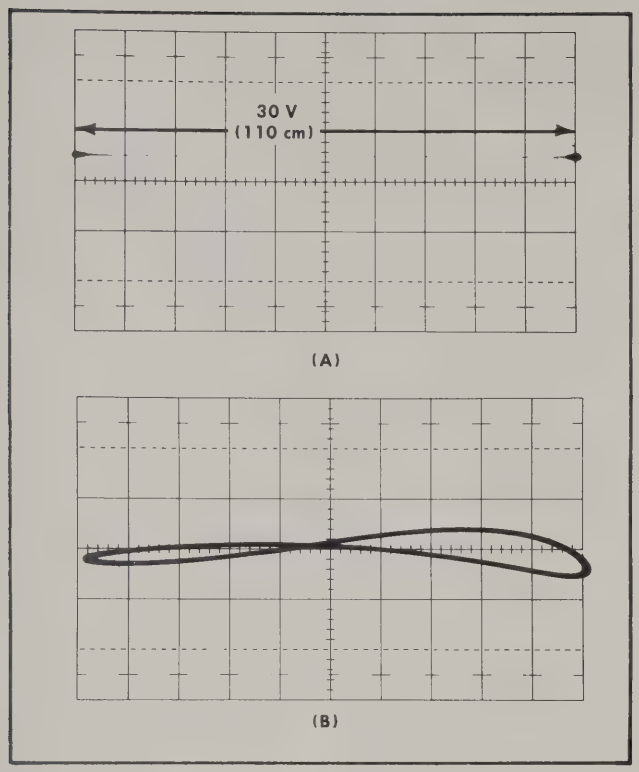


Fig. 5-5. (A) Horizontal deflection set at 30 V/10 cm. (B) Typical X-Y display at 1 mV/cm when a 1 kHz 30 V sine-wave signal is DC coupled to both inputs to the Type 1A6.

13. Check AC Low Frequency Response

a. Requirement—AC low frequency response 3 dB down at $\leq$2 Hz.

b. Decrease the Sine-Wave Generator output to minimum then set the +Input selector switch on the Type 1A6 to GND, —Input selector to DC and the VOLTS/CM switch to 50 mVOLTS.

c. Set the Sine-Wave Generator frequency to 2 Hz and adjust its control for a 4 cm display amplitude.

d. Set the —Input selector switch to AC and check the display for an amplitude $\geq$2.8 cm.

e. Set the —Input selector switch to GND and switch the +Input switch to AC.

f. Check for a display amplitude $\geq$2.8 cm.

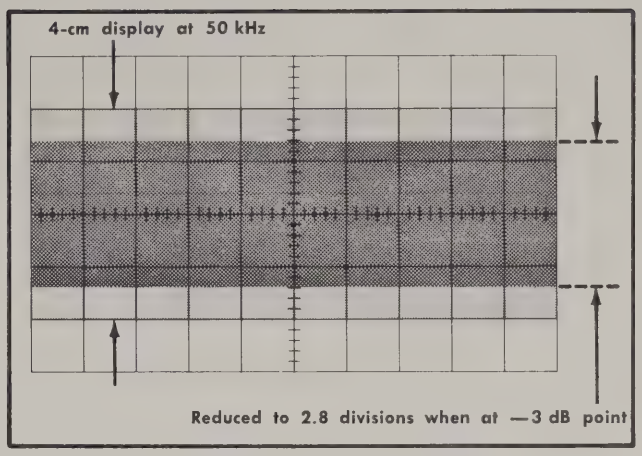


Fig. 5-6. Double exposure to show CRT display when checking the frequency response.

g. Set the test oscilloscope Horizontal Display switch to Normal and remove the Sine-Wave Generator, patch cords and cable from the Type 1A6 and oscilloscope.

14. Check Bandwidth

a. Requirement—(DC coupled) DC to $\geq$2 MHz.

b. Apply the output signal of the Constant Amplitude Signal Generator (Type 191) to the +INPUT connector through a coaxial cable and a 50 ohm termination. Set the +Input selector switch to DC.

c. Set the VOLTS/CM switch to 50 mVOLTS and set the frequency of the signal generator to 50 kHz, then adjust the amplitude control for a display amplitude of 4 cm.

d. Increase the frequency of the Constant Amplitude Signal Generator until the display amplitude has decreased to 2.8 cm. See Fig. 5-6.

e. Check—Constant Amplitude Signal Generator frequency must be equal to or higher than 2 MHz.

f. Remove the signal and all interconnecting cables to the Type 1A6.

This completes the Performance Check Procedure for the Type 1A6. If the unit has met all performance requirements given in this procedure, it is correctly calibrated and within specified tolerances.

NOTES

SECTION 6

CALIBRATION

Introduction

The Type 1A6 should be calibrated every 500 hours or every six months if used intermittently. If transistors, tubes or other components are replaced, the calibration of the repaired circuit should be checked.

Any required maintenance should be performed before proceeding with the calibration. Troubles which become apparent during calibration should also be corrected.

The sequence of the procedure is arranged to allow the unit to be calibrated with the least interaction of adjustments and reconnection of test equipment. The steps may be performed out of sequence or a step may be performed individually, providing interaction between adjustments is considered. Those that interact are usually pointed out within the procedure.

When performing steps individually or out of sequence, it may be necessary to refer to the preceding step(s) and/or Preliminary Procedure for additional setup information. Front-panel control settings are provided at major points in the procedure so a start can be made at any of those points.

NOTE

The procedure contains performance checks of the unit along with a complete calibration. Steps entitled Check are the performance checks. All other steps are entitled Adjust and the symbol ◑ is included in the Adjust title, so these steps can be easily located.

As an additional aid, a calibration record is provided at the beginning of this section. It lists all the Check and Adjust steps. Boxes are provided so each step can be checked off as it is completed. A brief explanation below each step is included so an experienced calibrator can use the check-off list as a condensed procedure.

EQUIPMENT REQUIRED (see Figs. 6-1 and 6-2)

General

The following equipment or its equivalent is required for complete calibration of the Type 1A6. Specifications given are the minimum necessary for accurate calibration of the instrument. All test equipment is assumed to be correctly calibrated and operating within its original specifications. If test equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

Special Calibration Fixtures

For the quickest and most accurate calibration, special calibration fixtures are used where necessary. All calibration fixtures listed under Equipment Required can be obtained from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Tektronix 530- 540- 550 or 580[1] Series Oscilloscope. Type 545B is used in this procedure.

2. Square-Wave Generator: Frequency 450 Hz to 1 MHz, risetime $\leq$15 ns. Tektronix Type 106.

3. Standard Amplitude Calibrator: Accuracy within $\pm$0.25%, amplitude range 100 mV to 100 V in calibrated steps, frequency appoximately 1 kHz. Tektronix Calibration Fixture 067-0502-00.

4. Constant Amplitude Signal Generator with 5 ns GR cable: Frequency range— 50 kHz to $>$2 MHz, output amplitude variable and accurate to within $\pm$3% from 50 kHz to 2 MHz. Tektronix Type 191 Constant Amplitude Signal Generator.

5. Sine-Wave Generator: Output frequency range—60 Hz to 100 kHz, output amplitude range $\leq$2 V to 30 V peak to peak.

6. Input RC Normalizer: RC = 1 MΩ × 33 pF, equipped with BNC connectors. Tektronix Part No. 067-0540-00.

7. Termination—50 Ω with BNC connectors. Tektronix Part No. 011-0049-00.

8. Adapter-GR to BNC male. Tektronix Part No. 017-0064-00.

9. T connector—BNC connectors. Tektronix Part No. 103-0030-00.

10. Dual-Input Connector — BNC connectors. Provides matched signal paths to both inputs of the Type 1A6. Tektronix Part No. 067-0525-00.

11. Two coaxial cables—50 Ω impedance, 42 inches long with BNC connectors. Tektronix Part No. 012-0057-00.

12. Patch cord: BNC to banana plug, length 18 inches. Tektronix Part No. 012-0090-00.

13. Plug-In Extension: Tektronix Part No. 013-0055-00.

Adjustment tools. See Fig. 6-2.

Description	Tektronix Part No.
a. Non-metallic screwdriver, 7 inch shaft	003-0001-00
b. Screwdriver, 3/32 inch bit, 3 inch shaft	003-0192-00

[1]**Type 81 Plug-In Adapter is required with the Type 580 Series oscilloscope.**

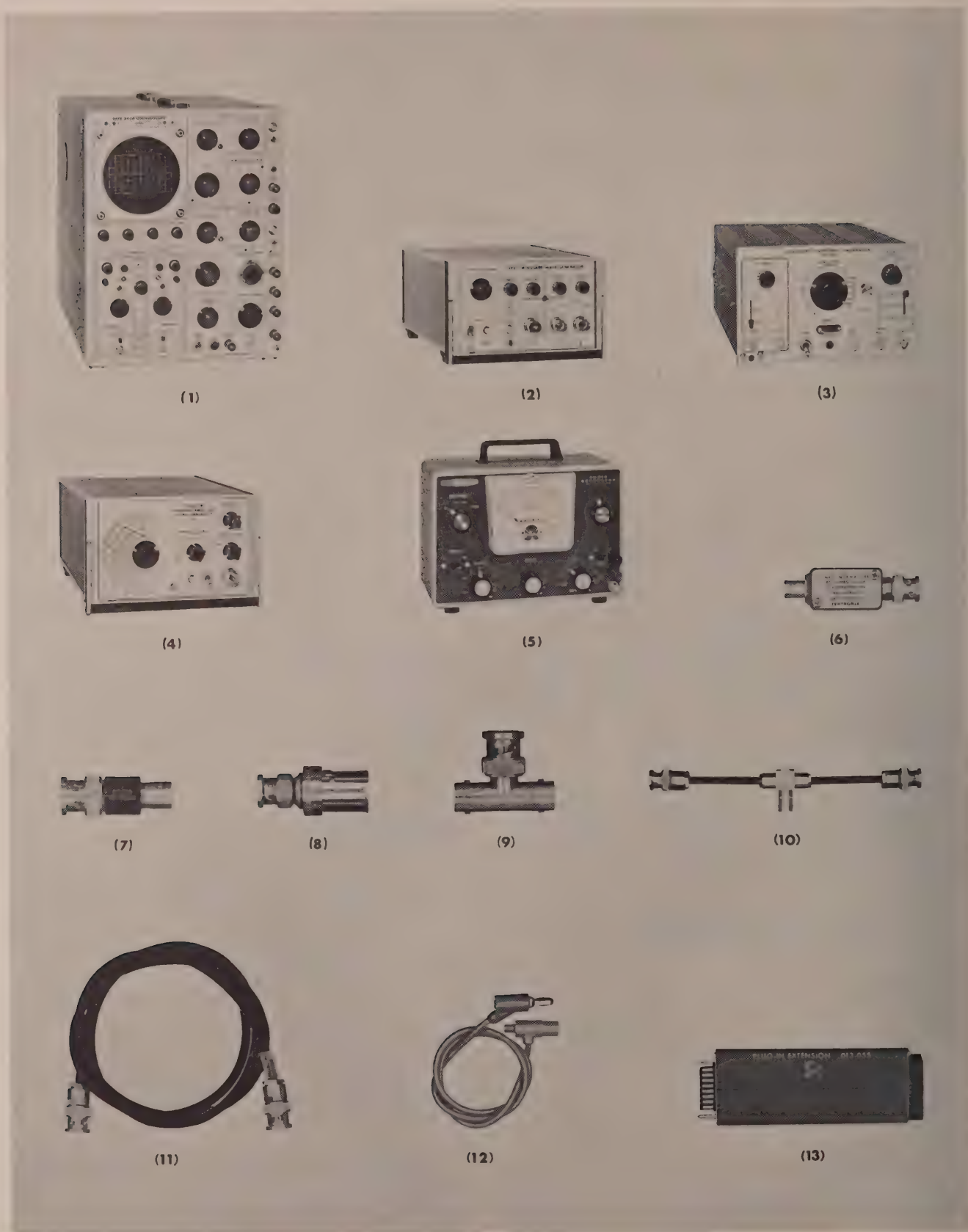


Fig. 6-1. Equipment required to calibrate the Type 1A6.

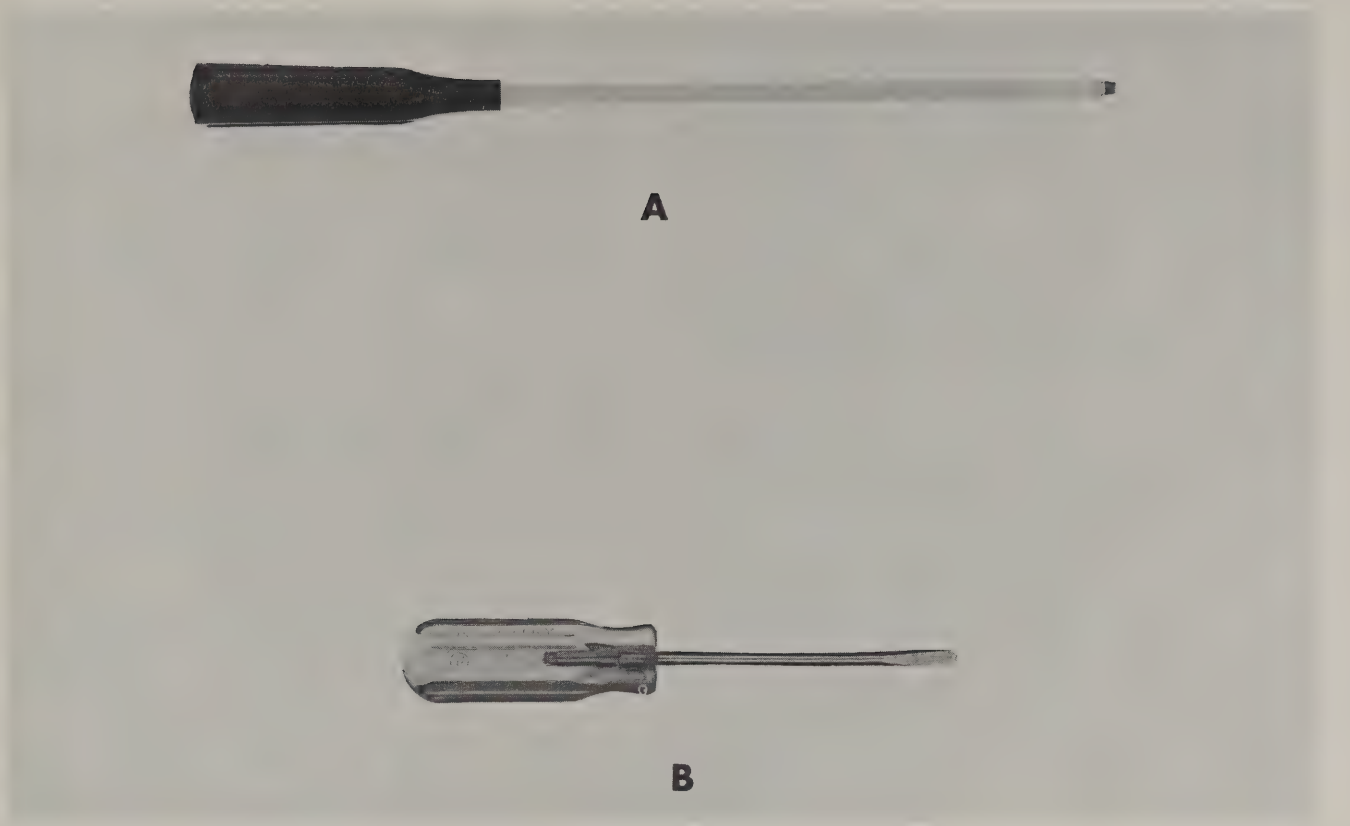


Fig. 6-2. Recommended adjustment tools.

CALIBRATION RECORD AND INDEX

This abridged Calibration Procedure is provided to aid in checking the operation of the Type 1A6. It may be used as a calibration guide by the experienced calibrator, or it may be used as a calibration record. Since the step numbers and titles correspond to those used in the complete Calibration Procedure, the abridged procedure serves as a ready index to any step within the procedure.

Tektronix Type 1A6 Serial No. _____

☐ 1. Adjust R110 (V114 and V214 heater balance) Page 6-5

Minimum trace movement as the VARIABLE control is rotated.

☐ 2. Adjust Step Attenuator Balance (R155-R255) Page 6-5

Minimum trace movement as the VOLTS/CM switch is changed through the range from 50 mV to 1 mV.

☐ 3. Check Microphonics Page 6-5

DC shift or prolonged ringing should not exceed 1 mV.

☐ 4. Adjust Grid Current Page 6-5

Adjust R101 (+Grid Current) and R201 (—Grid Current) for minimum trace shift as the input selector switch is switched from GND to DC position. VOLTS/CM selector at 1 mVOLTS position.

☐ 5. Adjust Gain and Check Variable Control Attenuation Range Page 6-7

Adjust GAIN for a 4 cm deflection at 50 mV/cm with 0.2 V applied. Ratio of 2.5:1 or better attenuation for the VARIABLE control.

☐ 6. Check AC-GND-DC Selector Switch Page 6-7

Input Calibrator signal with ground reference applied to the +INPUT should produce a display above GND trace position reference with the input selector switch in DC position and the signal should average about the reference with the input selector switch in the AC position.

☐ 7. Adjust DC Balance of the Input Attenuators Page 6-9

Adjust so the —Input attenuator DC attenuation matches the +Input attenuation.

☐ 8. Check VOLTS/CM Attenuator Accuracy Page 6-10

Check Attenuator accuracy within ±1.5%, 1 mV to 50 mV range and ±2.5%, .1 V to 50 V range, according to Table 6-1.

☐ 9. Adjust Input Compensation and Cross Neutralization Page 6-12

Adjust C103-C203 for optimum response of an applied square-wave. Adjust the cross neutralization capacitors C112-C212 for minimum aberration due to adjacent channel feedback.

☐ 10. Adjust Attenuator Compensation Page 6-13
Adjust + and — input attenuator compensating capacitors for optimum square-wave response according to Table 6-2.

☐ 11. Check and Adjust High Frequency Differential Balance Page 6-15
Adjust Com Mode Bal R139 for best CMRR with a 1 kHz sine-wave signal. Adjust C136 for best CMRR with 100 kHz sine-wave signal.

☐ 12. Check AC Coupled CMRR at 60 Hz Page 6-16

☐ 13. Check Risetime Page 6-17
≤175 ns at 50 mV, .1 V, 1 V and 10 V positions of the VOLTS/CM selector.

☐ 14. Measure Bandwidth Page 6-19
DC to 2 MHz at —3 dB point.

☐ 15. Check Operation of Input Overload Indicator Page 6-21
Lights when Calibrator signal ≥50 V is applied at 10 mV/cm to either or both inputs and turns off with ≤20 V applied.

Calibration Engineer _____

Date _____

Preliminary Procedure

1. Remove the left side panel from the oscilloscope and install the Type 1A6 in the plug-in compartment.

2. Connect the oscilloscope to a suitable power source within the regulating range of the scope power supplies.

3. Apply power to the required test equipment and turn the power switch on for all equipment. Allow a 30 minute warm-up period for test equipment and the Type 1A6 to stabilize before calibrating.

4. Preset the following front panel and internal controls to midrange: POSITION, GAIN, VARIABLE BALANCE, STEP ATTEN BALANCE and R110.

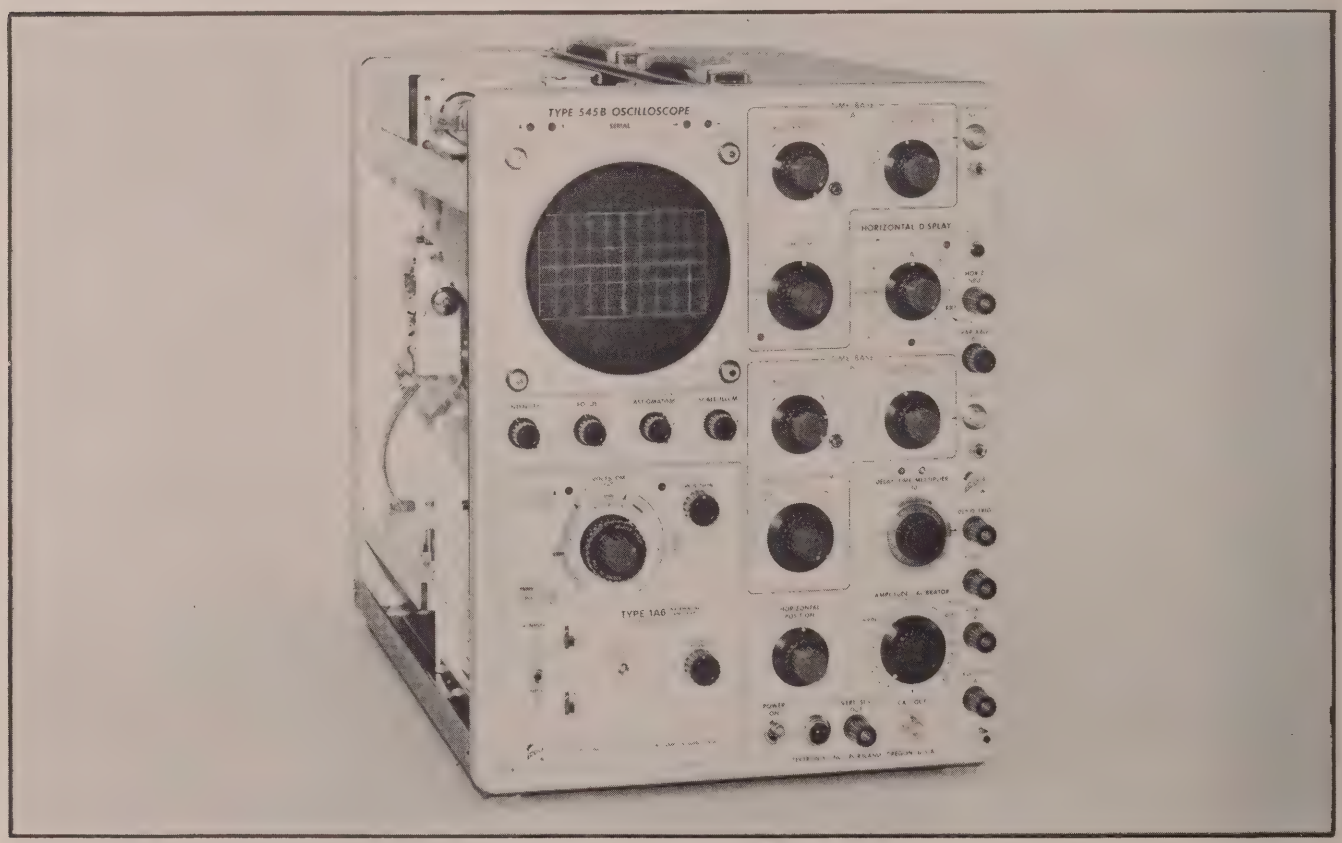


Fig. 6-3. Equipment setup for steps 1 through 4.

Type 1A6	
VOLTS/CM	50 mVOLTS
VARIABLE	CAL
POSITION	Midrange
VARIABLE BALANCE	Midrange
+INPUT Selector Switch	GND
—INPUT Selector Switch	GND

Test Oscilloscope	
Horizontal Display	Norm or Time Base A
Time/Cm	.5 mSEC
Variable	Calibrated
Triggering Mode	Int AC
Trigger Slope	—
Stability	Fully cw
Triggering Level	cw

1. Adjust R110 (V114 and V214 heater balance)

a. Equipment setup is shown in Fig. 6-3.

b. Adjust R110 for minimum vertical movement of the trace as the VARIABLE control is rotated through its range.

c. Change the VOLTS/CM switch to 10 mVOLTS and again adjust R110 for minimum trace movement as the VARIABLE control is rotated.

d. Set the VARIABLE control to CAL position.

2. Adjust Step Attenuator Balance (R155-R255) and VARIABLE BALANCE controls

a. Equipment setup is given in step 1.

b. Adjust STEP ATTEN BALANCE for minimum vertical trace movement as the VOLTS/CM selector is switched through the range from 50 mVOLTS to 1 mVOLTS.

c. Adjust VARIABLE BALANCE control for minimum trace movement as the VARIABLE control is rotated with the VOLTS/CM selector at 1 mVOLT position.

3. Check Microphonics

a. Test equipment setup is given in step 2.

b. Lightly tap the front panel of the Type 1A6 with the fingers and note the amplitude and duration of microphonic noise with the VOLTS/CM sensitivity at 1 mVOLT position. DC shift or prolonged ringing is typically less than 1 cm.

c. If microphonics are excessive, replace the input tubes V114 and V214.

4. Adjust Grid Current

a. Test equipment setup is given in step 2.

b. Set the VOLTS/CM switch to 1 mVOLT position and connect a 50 Ω termination to the +INPUT connector. Set both Input switches to GND. Position the trace to the graticule center horizontal line for reference.

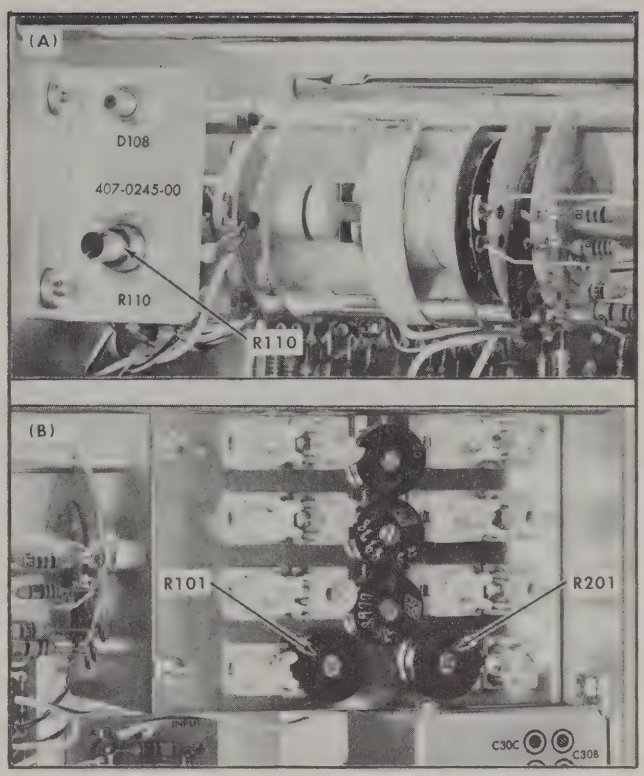


Fig. 6-4. (A) Location of R110. (B) Location of R101 and R201.

c. Adjust R101 (+Grid Current, see Fig. 6-4B) for minimum vertical trace movement as the +INPUT AC-GND-DC switch is switched between GND and AC position.

d. Set the +Input selector switch to GND position, remove the 50 Ω termination from the +INPUT connector and connect it to the —INPUT connector.

e. Adjust R201 (—Grid Current) for minimum vertical trace movement as the —Input selector is switched between GND and AC position.

f. Remove the 50 Ω termination and return the —Input selector switch to GND position.

g. Trace shift due to grid current must be not more than ±1 cm, if excessive; replace both input tubes.

NOTES

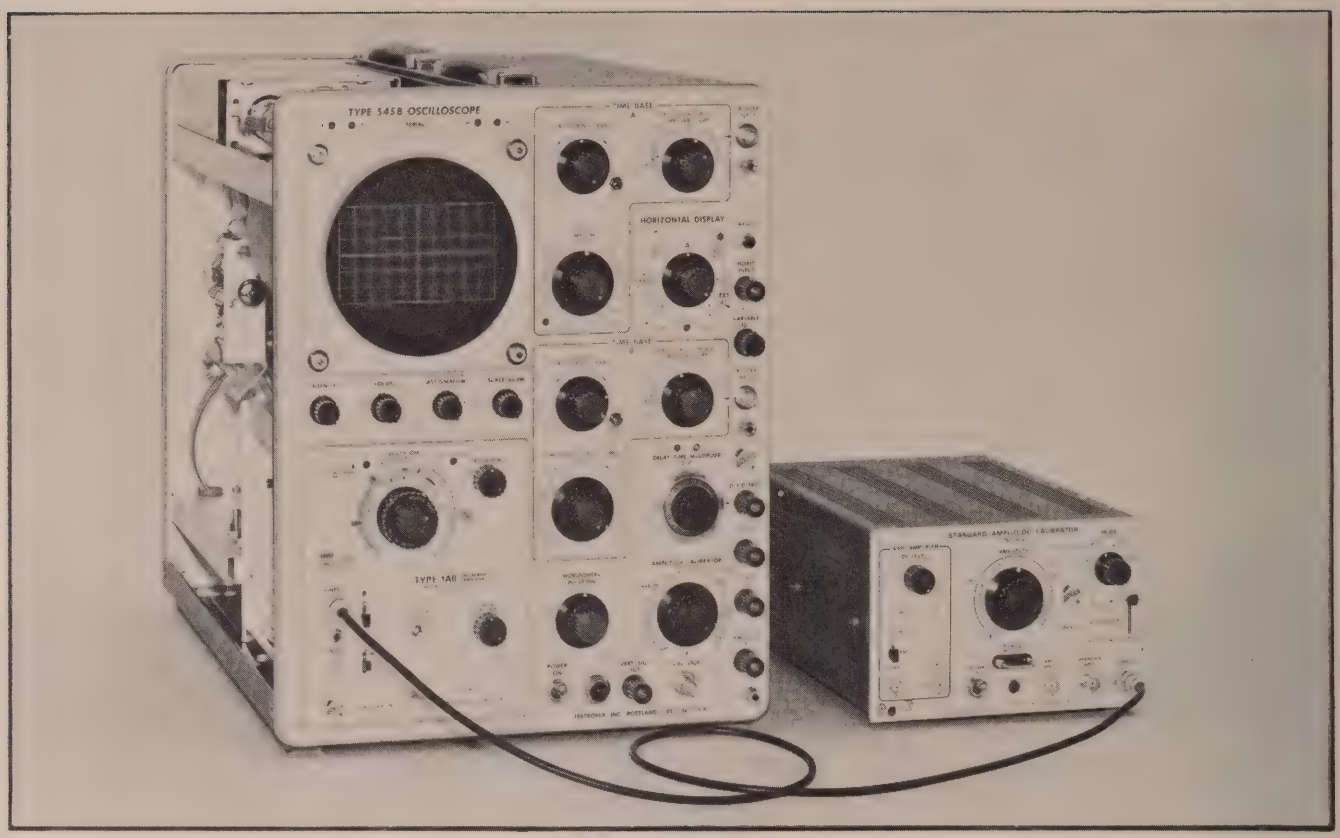


Fig. 6-5. Equipment setup for steps 5 and 6.

Type 1A6	
VOLTS/CM	50 mVOLTS
VARIABLE	CAL
POSITION	Midrange or centered trace.
VARIABLE BALANCE	Adjusted for minimum vertical trace movement as the VARIABLE control is rotated.
STEP BALANCE	Adjust for minimum vertical trace movement as the VOLTS/CM selector is switched through the 50 mVOLT to 1 mVOLT positions.
+INPUT Selector Switch	DC
—INPUT Selector Switch	GND

Test Oscilloscope	
Horizontal Display	Norm or Time Base A
Time/Cm	.5 mSEC
Variable	Calibrated
Triggering Mode	Int AC
Trigger Slope	—
Stability	**Preset**
Triggering Level	**Adjusted for stable display**

NOTES

5. Adjust Gain and Check VARIABLE Control Attenuation Range

a. Test equipment setup is shown in Fig. 6-5.

b. Set the VOLTS/CM switch to 50 mVOLTS, then apply 0.2 volts of signal from the Standard Amplitude Calibrator to the +INPUT connector.

c. With the Input selector switch in DC position, adjust the GAIN control (front panel) for a display amplitude of exactly 4 cm.

d. Set the VOLTS/CM switch to 1 mVOLTS position and adjust the Standard Amplitude Calibrator for a 5 mVOLT output signal.

e. Adjust R173 (1 mV Gain, Fig. 6-6) for a display amplitude of exactly 5 cm.

f. Rotate the VARIABLE control fully counterclockwise.

g. Check—Display amplitude is 2 cm or less (attenuation ratio 2.5:1 or more) and UNCAL neon is lit.

h. Return the VARIABLE control to the CAL position.

6. Check AC-GND-DC Switch

a. Test equipment setup is given in step 5.

b. Center the trace vertically with the POSITION control, then switch +Input selector switch to DC and the VOLTS/CM switch to 50 mVOLTS.

c. Apply a .1 V signal from the Standard Amplitude Calibrator to the +INPUT connector.

d. Check for positive-going (upward from vertical center) 2 cm signal.

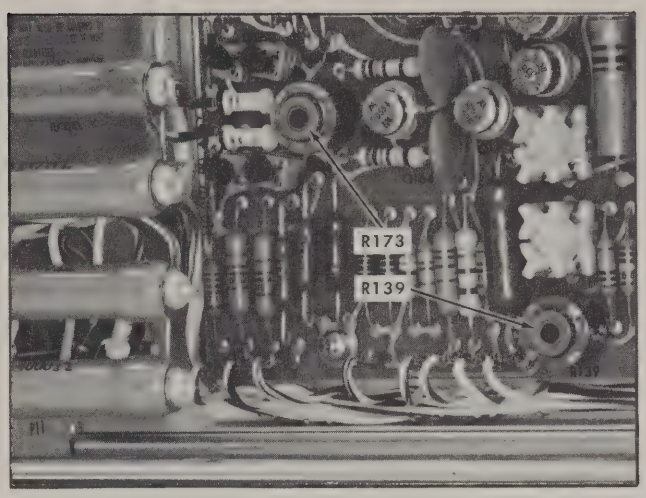


Fig. 6-6. Location of R173, (1 V Gain).

e. Change the switch to GND position and check for no signal.

f. Change the switch to AC position and check for 2 cm signal amplitude, centered about the center horizontal graticule line.

g. Remove the signal from the +INPUT connector and apply the Standard Amplitude Calibrator signal to the —INPUT connector.

h. Repeat the check for the —Input selector switch. With the Input selector switch in the DC position signal will deflect downward (negative going).

NOTES

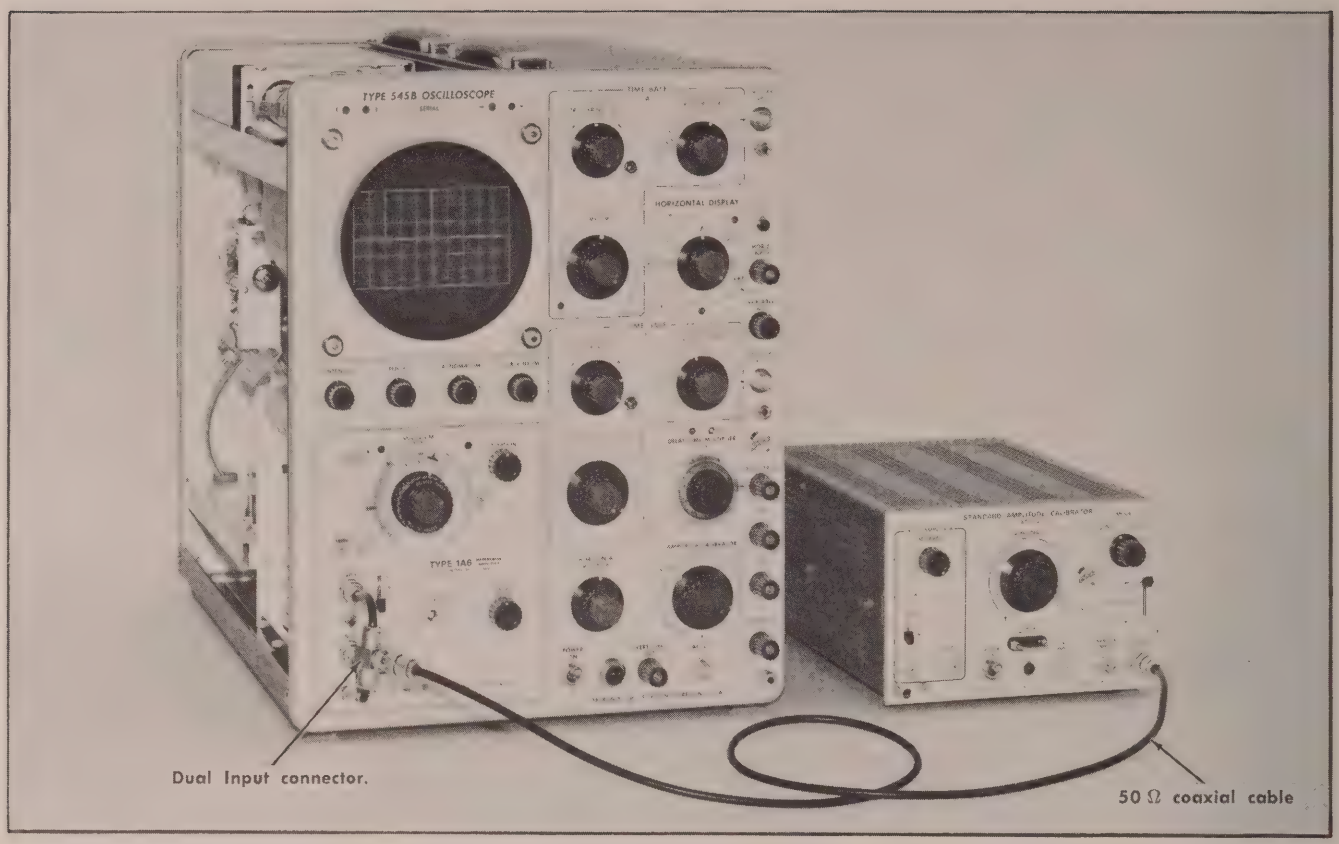


Fig. 6-7. Equipment setup for step 7.

Type 1A6	
VOLTS/CM	**.1**
VARIABLE	CAL
POSITION	Midrange or centered trace.
VARIABLE BALANCE	Adjust for minimum trace movement as the VARIABLE control is rotated.
STEP ATTEN BALANCE	Adjusted for minimum vertical trace movement as the VOLTS/CM switch is rotated between the 50 mV to 1 mV range
+INPUT Selector Switch	DC
—INPUT Selector Switch	**DC**

Test Oscilloscope	
Horizontal Display	Norm or time Base A
Time/Cm	.5 mSEC
Variable	Calibrated
Triggering Mode	Int AC
Trigger Slope	—
Stability	Preset
Triggering Level	Adjusted for stable display

NOTES

7. Adjust DC Balance of the Input Attenuators

a. Equipment setup is given in Fig. 6-7.

b. Set the VOLTS/CM switch to .1 VOLT position.

c. Apply the output from the Standard Amplitude Calibrator through a 50 Ω cable and dual input connector to both the + and — INPUT connectors of the Type 1A6. Set the calibrator for a 100 volt peak-to-peak square-wave output signal.

d. Adjust R30E (Fig. 6-8) for minimum signal amplitude.

e. Set the VOLTS/CM switch to 1 VOLT.

f. Adjust R32E for minimum signal amplitude. See Fig. 6-8.

g. Set the VOLTS/CM switch to 10 VOLTS.

h. Adjust R34E for minimum signal amplitude.

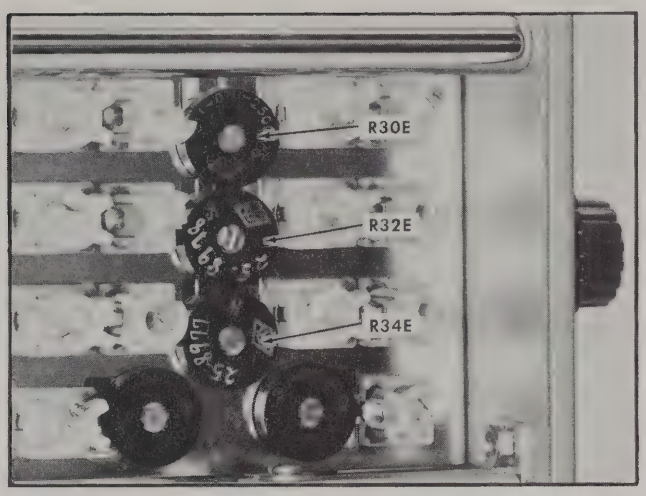


Fig. 6-8. Location of DC Balance adjustment R30E, R32E and R34E.

NOTES

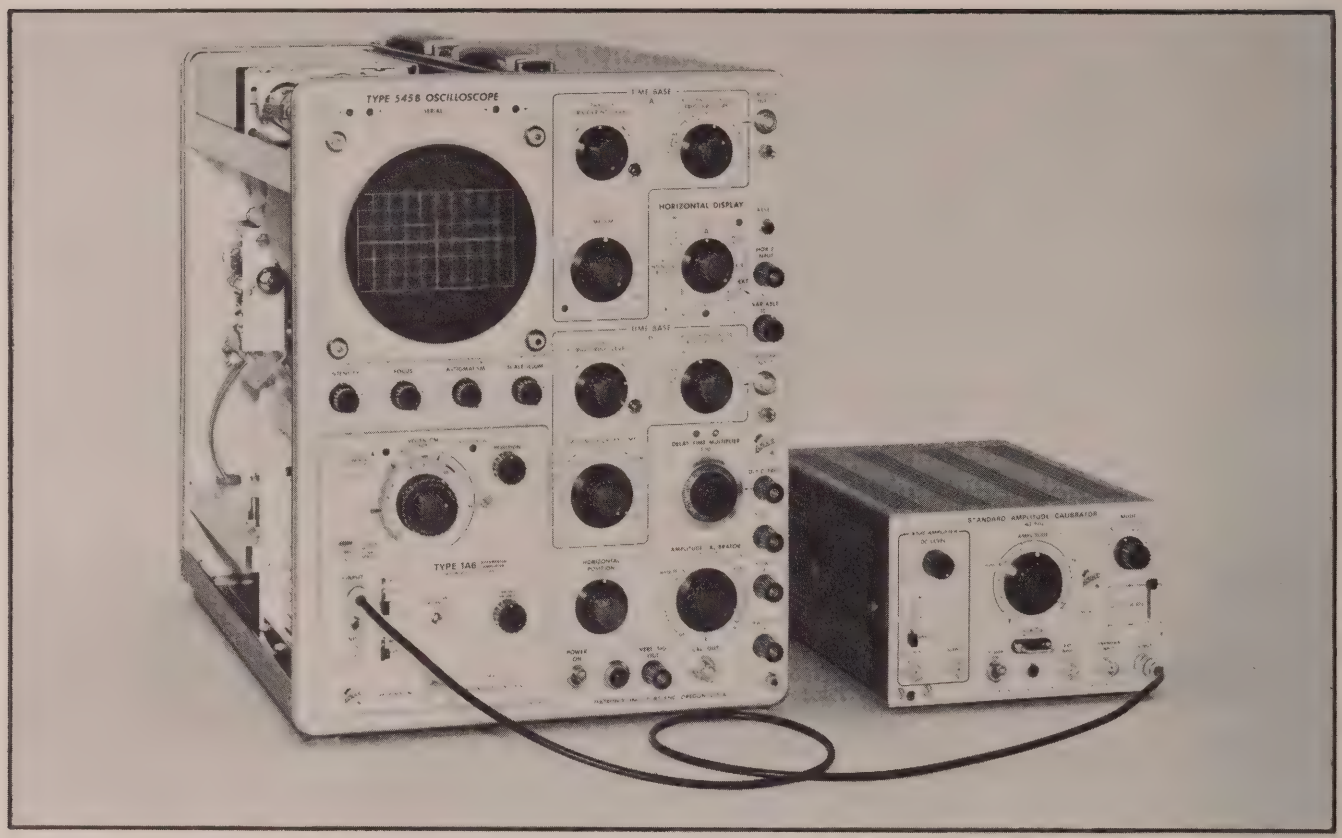


Fig. 6-9. Equipment setup for step 8.

Type 1A6

VOLTS/CM	**1 mVOLTS**
VARIABLE	CAL
POSITION	Midrange or centered trace
VARIABLE BALANCE	Adjusted for minimum trace movement as the VARIABLE control is rotated.
STEP ATTEN BALANCE	Adjusted for minimum vertical trace movement as the VOLTS/CM switch is rotated between the 50 mV to 1 mV range
+INPUT Selector Switch	DC
—INPUT Selector Switch	**GND**

Test Oscilloscope

Horizontal Display	Norm or Time Base A
Time/Cm	.5 mSEC
Variable	Calibrated
Triggering Mode	Int AC
Trigger Slope	—
Stability	Preset
Triggering Level	Adjusted for stable display

Standard Amplitude Calibrator

Amplitude	**1 mVOLT**
Mode	**output**

8. Check VOLTS/CM Attenuator Accuracy

a. Equipment setup is shown in Fig. 6-9.

b. Apply the output signal of the Standard Amplitude Calibrator to the +INPUT connector of the Type 1A6 and check the accuracy of each position of the attenuator as shown in Table 6-1.

c. Disconnect the Standard Amplitude Calibrator signal from the INPUT connector.

TABLE 6-1

VOLTS/CM	Standard Amplitude Calibrator Output	Vertical Signal Amplitude
1 mVOLTS	5 mVOLT	Adjusted to 5 cm (step 5)
2 mVOLTS	10 mVOLT	5 cm, ±0.75 mm
5 mVOLTS	20 mVOLT	4 cm, ±0.6 mm
10 mVOLTS	50 mVOLT	5 cm, ±0.75 mm
20 mVOLTS	.1 VOLT	5 cm, ±0.75 mm
50 mVOLTS	.2 VOLT	Adjusted to 4 cm (step 5)
.1 VOLTS	.5 VOLT	5 cm, ±1.25 mm
.2 VOLTS	1 VOLT	5 cm, ±1.25 mm
.5 VOLTS	2 VOLT	4 cm, ±1.00 mm
1 VOLTS	5 VOLT	5 cm, ±1.25 mm
2 VOLTS	10 VOLT	5 cm, ±1.25 mm
5 VOLTS	20 VOLT	4 cm, ±1.00 mm
10 VOLTS	50 VOLT	5 cm, ±1.25 mm
20 VOLTS	100 VOLT	5 cm, ±1.25 mm
	100 VOLT	2 cm, ±0.5 mm

NOTES

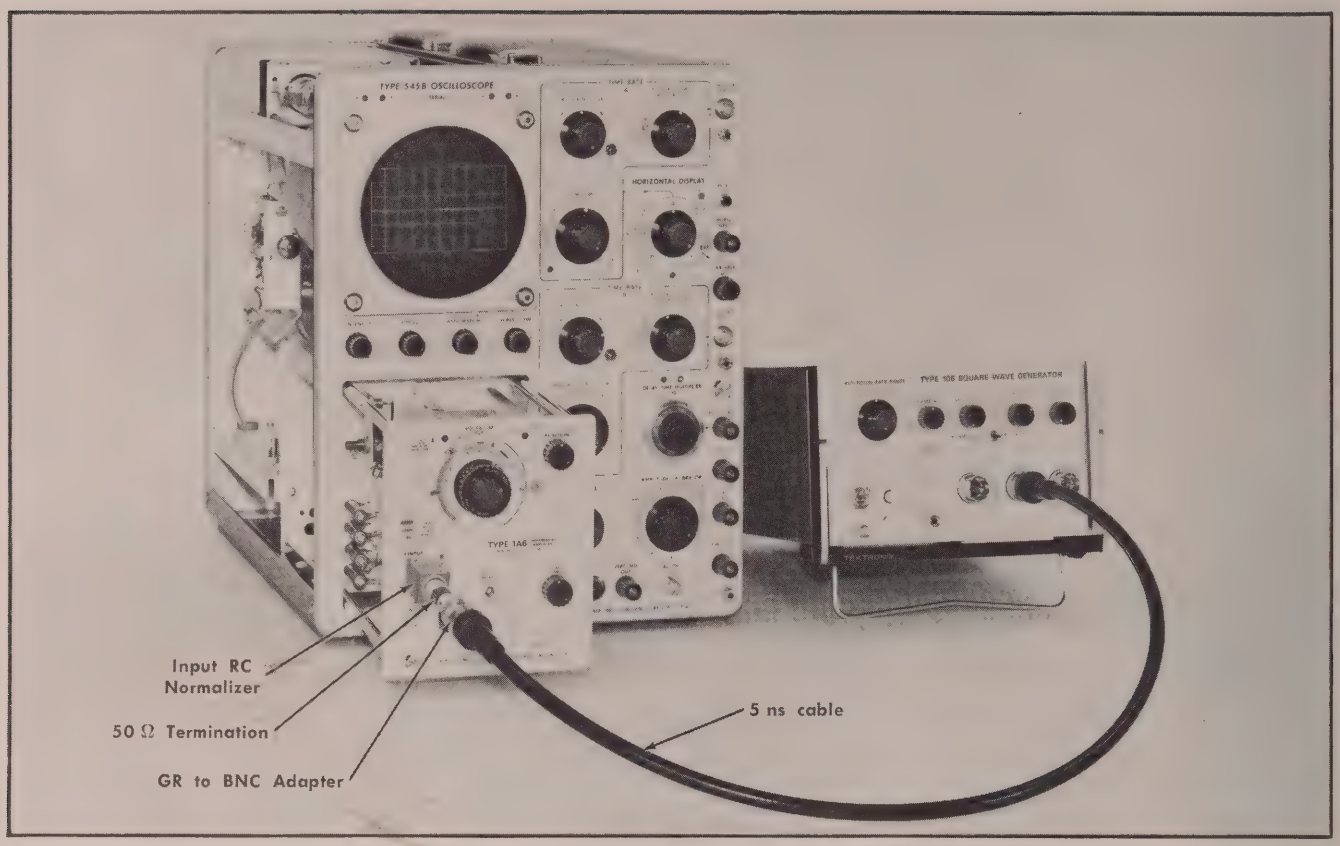


Fig. 6-10. Equipment setup for steps 9 and 10.

Type 1A6	
VOLTS/CM	**50 mVOLTS**
VARIABLE	CAL
POSITION	Midrange or centered trace
VARIABLE BALANCE	Adjusted for minimum trace movement as the VARIABLE control is rotated.
STEP ATTEN BALANCE	Adjusted for minimum vertical trace movement as the VOLTS/CM switch is rotated between the 50 mV to 1 mV range
+INPUT Selector Switch	DC
—INPUT Selector Switch	GND

Test Oscilloscope	
Horizontal Display	Norm or Time Base A
Time/Cm	.5 mSEC
Variable	Calibrated
Triggering Mode	Int AC
Trigger Slope	—
Stability	Preset
Triggering Level	Adjusted for stable display

Square-Wave Generator	
Repetition Rate	**1 kHz**

9. Adjust Input Compensation and Cross Neutralization

a. Equipment setup is given in Fig. 6-10.

b. Apply the +Output signal of the Square-Wave Generator (Type 106) through an input RC Normalizer (33 pF × 1 MΩ) to the +INPUT connector of the Type 1A6.

c. Set the —Input selector switch to GND position and the +Input selector switch to DC. Adjust the output of the Square-Wave Generator for a display amplitude of 5 cm.

d. Adjust C103 for optimum response. (Optimum square corner and flat top waveform.) See Fig. 6-11.

e. Remove the Input RC Normalizer and signal from the +INPUT connector and apply them to the —INPUT connector. Set the +Input selector switch to GND position and the —Input selector to DC. Adjust for a display amplitude of 5 cm.

f. Adjust C203 for optimum square-wave response. See Fig. 6-11 and 6-12.

g. Adjust the cross neutralization capacitor C212 for minimum change to the waveform when the +Input selector switch is switched between GND and DC positions.

h. Remove the Input RC Normalizer and signal from the —INPUT connector and reapply the signal to the +INPUT connector.

i. Adjust cross neutralization capacitor C112 for minimum change in the waveform as the —Input selector switch is switched between GND and DC positions.

j. Repeat steps b through i until there is no interaction between adjustment.

10. Adjust Attenuator Compensation ◑

a. Equipment setup is given in step 9.

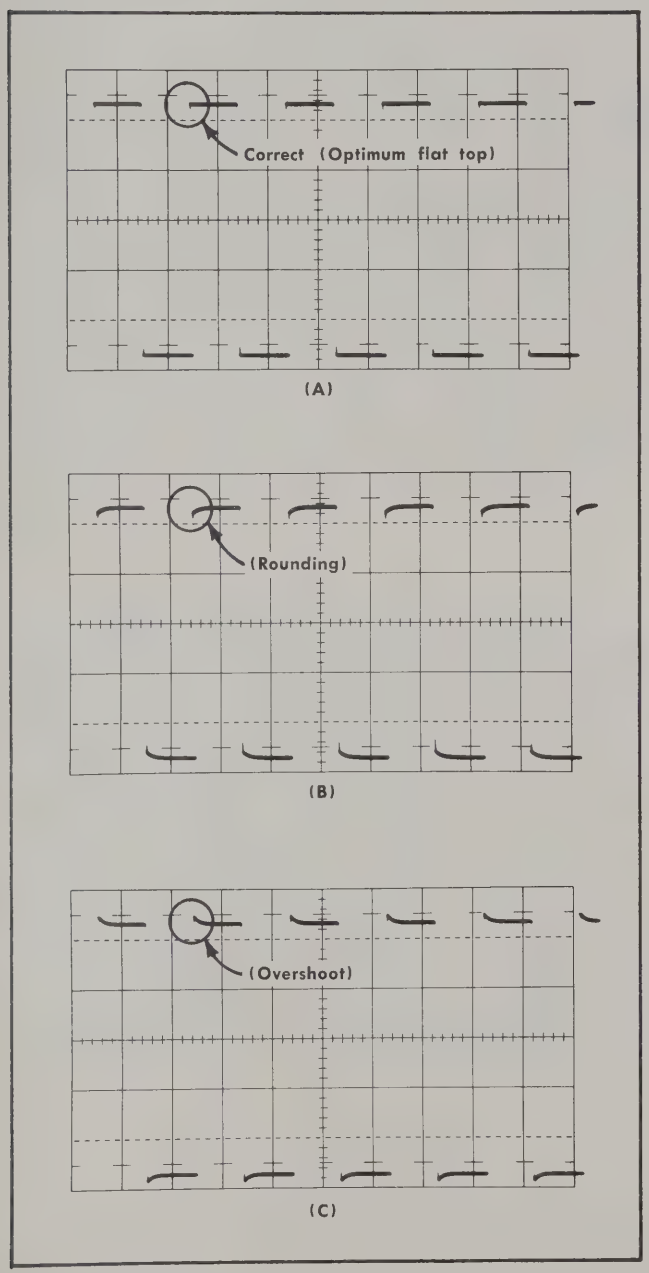
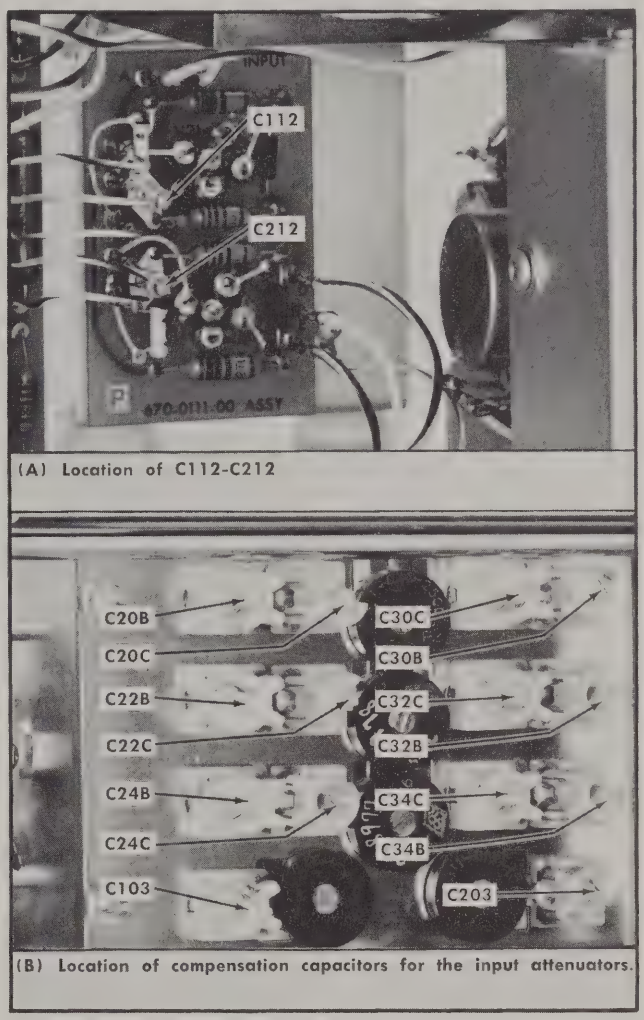


Fig. 6-11. Adjusting input compensation to standardize the attenuator time constant. Time/CM = 0.5 ms. (A) Correct response, (Aberrations ≤2% or 1 mm). (B) Incorrect response (rounding of the corner). (C) Incorrect response (Overshoot of the corner).

b. Apply the +Output square wave from the Square-Wave Generator through the Input RC Normalizer (33 pF × 1 MΩ) to the INPUT connector designated in Table 6-2. Adjust the output amplitude to maintain a 5 cm display amplitude for each position of the VOLTS/CM selector.

c. Adjust the + and — input attenuator compensation capacitors as per Table 6-2 for optimum square corner and waveform flat top. See Fig. 6-11 and 6-12. Transient response; aberrations ≤2%.



(A) Location of C112-C212

(B) Location of compensation capacitors for the input attenuators.

Fig. 6-12. Input and cross-neutralization adjustments. (A) Location of C112-C212. (B) Location of compensation capacitors for the input attenuators.

TABLE 6-2

Input Connector for Signal Application	+Input Switch Position	—Input Switch Position	VOLTS/CM Position	Adjust for Optimum Response
—INPUT	GND	DC	.1 VOLT	C30B—C30C
+INPUT	DC	GND	.1 VOLT	C20B—C20C
+INPUT	DC	GND	1 VOLT	C22B—C22C
—INPUT	GND	DC	1 VOLT	C32B—C32C
—INPUT	GND	DC	10 VOLT	C34B—C34C
+INPUT	DC	GND	10 VOLT	C24B—C24C

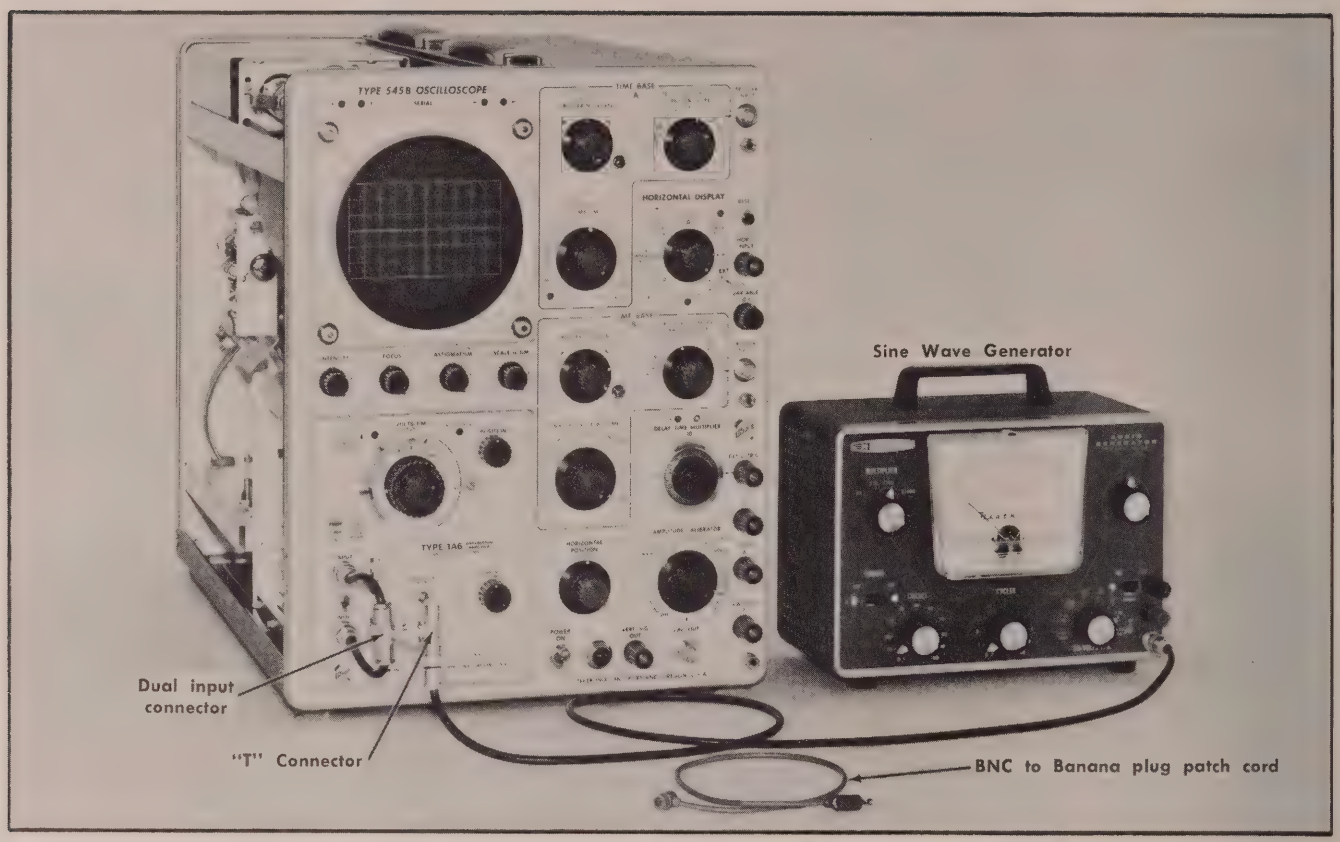


Fig. 6-13. Equipment setup for step 11 and 12.

Type 1A6

VOLTS/CM	1 mVOLT
VARIABLE	CAL
POSITION	Midrange or centered trace
VARIABLE BALANCE	Adjusted for minimum trace shift as the VARIABLE control is rotated.
STEP ATTEN BALANCE	Adjusted for minimum vertical trace movement as the VOLTS/CM switch is rotated between the 50 mV to 1 mV range
+INPUT Selector Switch	DC
—INPUT Selector Switch	GND

Test Oscilloscope

Horizontal Display	Norm or Time Base A
Time/Cm	.5 mSEC
Variable	Calibrated
Triggering Mode	Int AC
Trigger Slope	—
Stability	Preset
Triggering Level	Adjust for stable display

Sine-Wave Generator

Frequency	**1 kHz**
Amplitude	**30 V peak to peak**

NOTES

11. Check and Adjust High Frequency Differential Balance

a. Equipment setup is given in Fig. 6-13.

b. Apply a 1 kHz signal from the Sine-Wave Generator through a coaxial cable, a T connector and a dual input connector to the two INPUT connectors of the Type 1A6. See Fig. 6-13.

c. With the —INPUT selector switch in GND position and the +INPUT selector at DC, adjust the Sine-Wave Generator amplitude control for a 30 volt peak-to-peak signal (3 cm display amplitude with the VOLTS/CM selector in the 10 VOLT position, the VARIABLE control in CAL and step 5 completed).

d. Connect a patch cord between the T connector and the oscilloscope Ext Horiz Input connector. Set the Horizontal Display switch to ×10 Ext position and both Type 1A6 Input switches to GND position.

e. Adjust the test oscilloscope external horizontal variable 1-10 control for a horizontal deflection amplitude of 10 cm.

f. Change the Type 1A6 VOLTS/CM switch to 1 mVOLTS position and set both Input selector switches to DC position.

g. Adjust Com Mode Bal R139 for minimum tilt of the horizontal line. See Fig. 6-14 and 6-15. A tilt of 3 cm at 1 mVOLT/CM is equivalent to a CMRR of 10,000:1 (3 × 1 mV = 3 mV; 30 V/3 mV = 10,000).

h. Increase the Sine-Wave Generator frequency to 100 kHz, remove the patch cord and adjust the Sine-Wave Generator output to 30 volts peak to peak as in step c above.

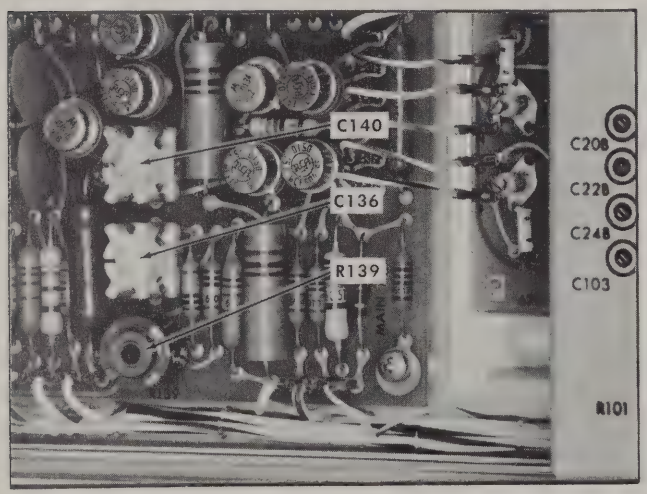
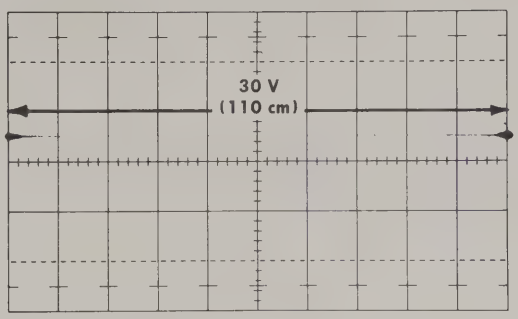
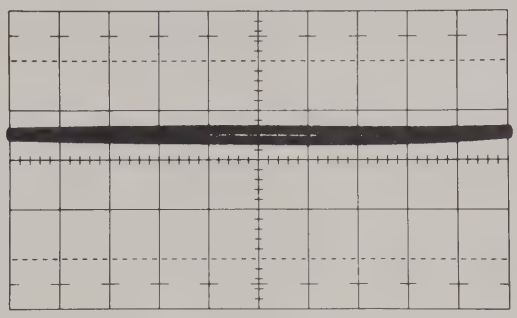


Fig. 6-14. Location of Com Mode Bal R139 adjustment, C136 and C140.

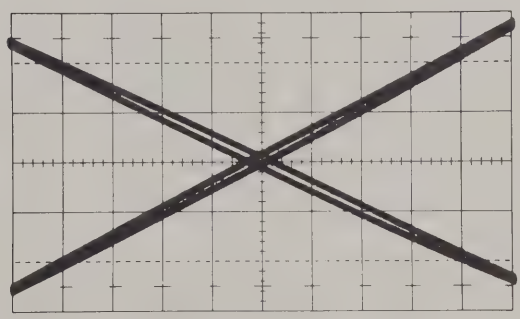
i. Repeat steps d, e and f above then adjust C136 for a closed loop (minimum loop opening) and C140 for minimum tilt. See Fig. 6-16.



(A) Horizontal deflection set at 30 V/10 cm.



(B) Typical 100-Hz X-Y display obtained when R139 is properly adjusted. Indicated vertical deflection is well within the 3 cm requirement.



(C) Double exposure showing two effects obtained when the Common Mode Balance R139 is incorrectly adjusted.

Fig. 6-15. Typical displays obtained when performing step 11. (A) Horizontal deflection set at 30 V/10 cm. (B) Typical 100-Hz X-Y display obtained when R139 is properly adjusted. Indicated vertical deflection is well within the 3-cm requirement.

CAUTION

Shorting the rotor to the stator plates of capacitors C136 or C140 will damage or destroy transistors Q114-Q214. Use caution if a metal tipped screwdriver is used to adjust C136-C140.

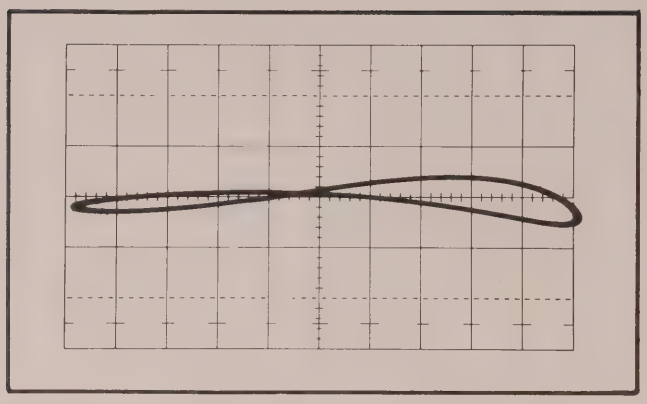


Fig. 6-16. Typical display obtained when C136 and C140 are correctly adjusted at 100 kHz. Tilt is within 3 cm.

12. Check AC Coupled CMRR at 60 Hz and AC Low Frequency Response

a. Equipment setup is given in step 11.

b. Set the Sine-Wave Generator frequency to 60 Hz and adjust its output to 30 volts peak to peak using the procedure in step 11b through 11e.

c. Set the Type 1A6 VOLTS/CM switch to 10 mVOLTS and both Input selector switches to AC position.

d. Check the vertical deflection of the X-Y display. Must not exceed 1.5 cm (CMRR = 2,000:1 or higher).

e. Decrease the Sine-Wave Generator output to minimum, then set the +Input selector switch on the Type 1A6 to GND, —Input selector to DC and the VOLTS/CM switch to 50 mVOLTS.

f. Set the Sine-Wave Generator frequency to 2 Hz and adjust its output control for a 4-cm display amplitude.

g. Set the —Input selector switch to AC and check the display for an amplitude $\geq$2.8 cm.

h. Set the —Input selector switch to GND and switch the +Input switch to AC.

i. Check for a display amplitude $\geq$2.8 cm.

j. Set the test oscilloscope Horizontal Display switch to Normal and remove the Sine-Wave Generator, patch cords and cable from the Type 1A6 and oscilloscope.

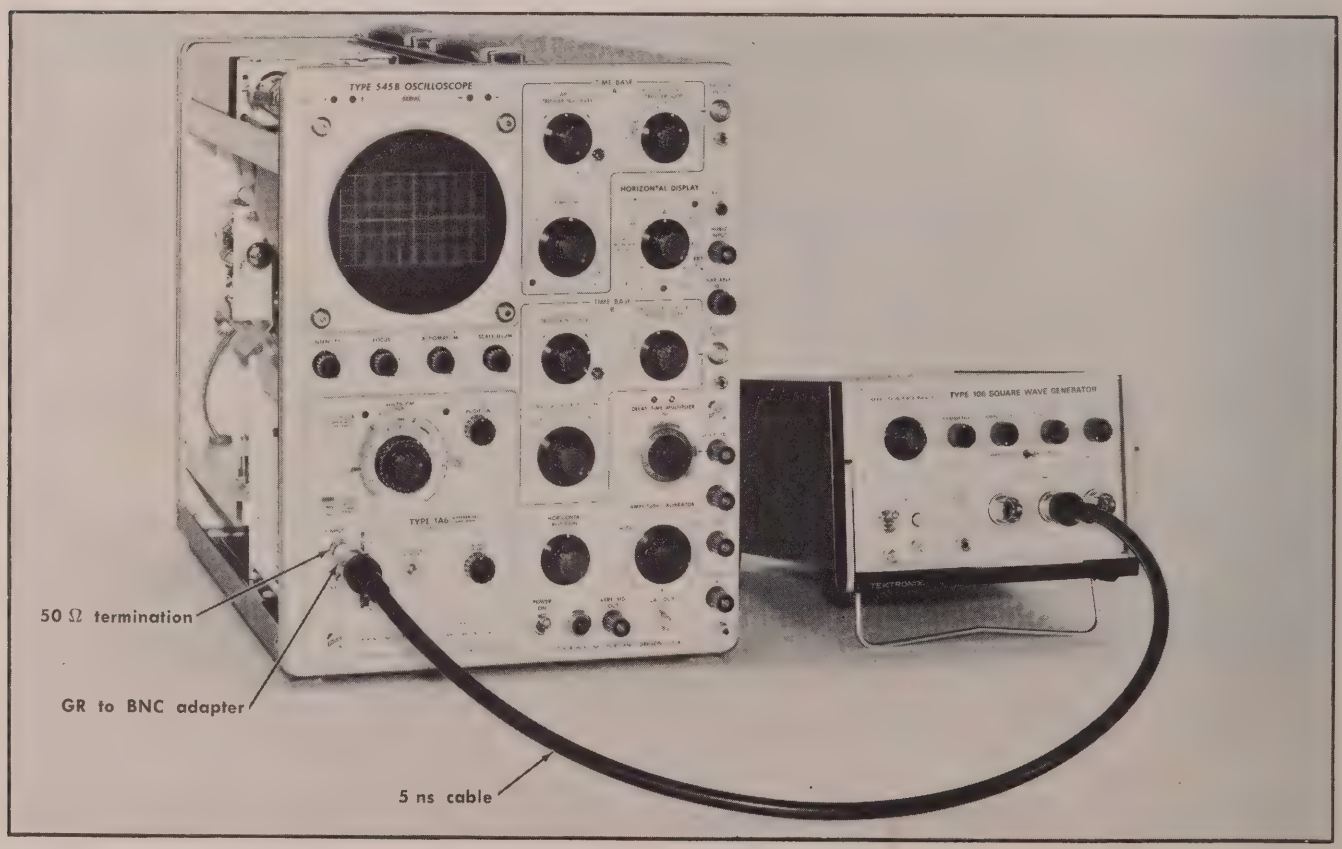


Fig. 6-17. Equipment setup for step 13.

Type 1A6

VOLTS/CM	**50 mVOLTS**
VARIABLE	CAL
POSITION	Midrange or centered trace
VARIABLE BALANCE	Adjusted for minimum trace movement as the VARIABLE control is rotated
STEP ATTEN BALANCE	Adjusted for minimum vertical trace movement as the VOLTS/CM switch is rotated between the 50 mV to 1 mV range
+INPUT Selector Switch	DC
—INPUT Selector Switch	GND

Test Oscilloscope

Horizontal Display	Norm or Time Base A
Time/Cm	.5 mSEC
Variable	Calibrated
Triggering Mode	Int AC
Trigger Slope	—
Stability	Preset
Triggering Level	Adjust for stable display

Square Wave Generator (Type 106)

Frequency	**100 kHz**

13. Check Risetime

a. Equipment setup is shown in Fig. 6-17.

b. Apply a 100 kHz signal from the Square-Wave Generator (Type 106) through a coaxial cable, GR to BNC adapter and 50 ohm termination to the +INPUT connector.

c. Adjust the generator output control for a display amplitude of 5 cm.

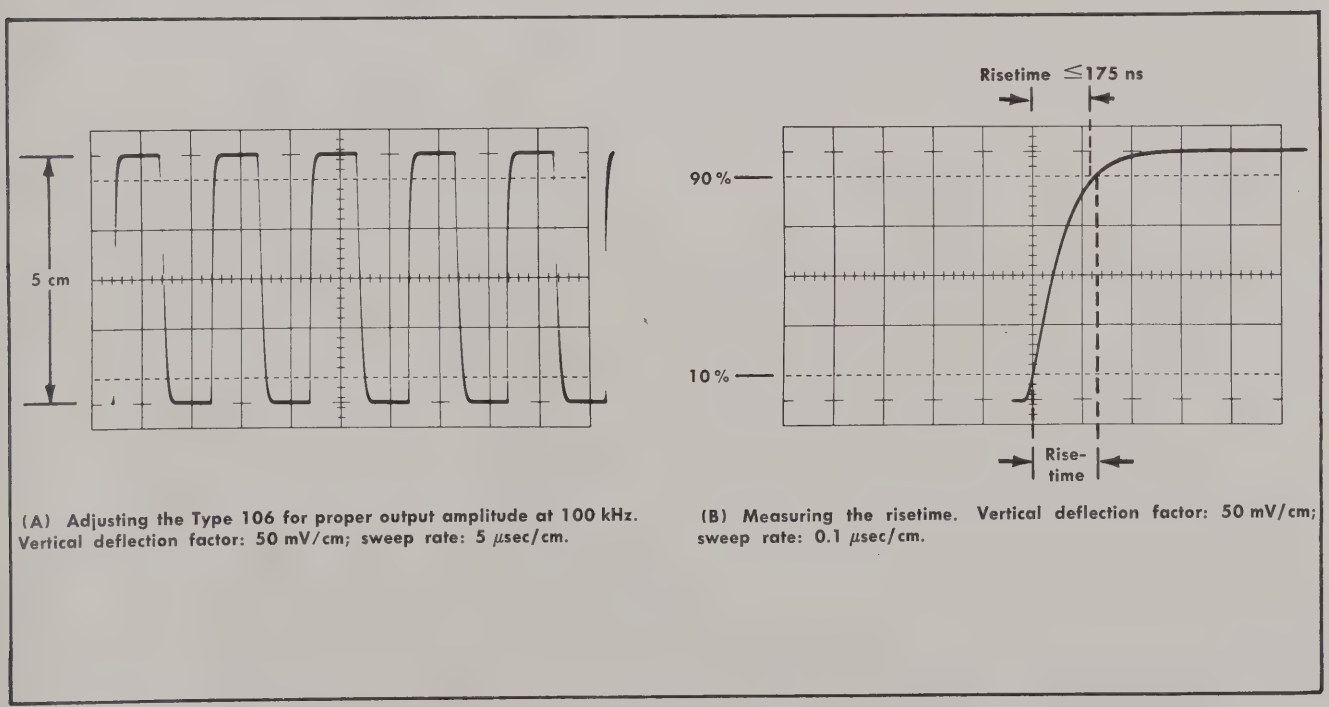
d. Set the oscilloscope Time/Cm selector to a fast sweep rate position (.1 μSEC or faster) and adjust the triggering controls so the rise portion of the square-wave is displayed. See Fig. 6-18.

e. Measure the risetime of the square wave as shown in Fig. 6-18. Risetime should equal or be less than 175 ns. (Equivalent to bandwidth of 2 MHz).

f. Set the Type 1A6 VOLTS/CM switch to 1 mVOLT position and adjust the output of the generator for a display amplitude of 5 cm.

g. Measure the risetime. Risetime $\leq$175 ns.

h. Repeat steps b through g to measure the risetime at the .1 VOLT, 1 VOLT and 10 VOLT positions of the VOLTS/CM switch. Risetime $\leq$175 ns in all positions.



(A) Adjusting the Type 106 for proper output amplitude at 100 kHz. Vertical deflection factor: 50 mV/cm; sweep rate: 5 μsec/cm.

(B) Measuring the risetime. Vertical deflection factor: 50 mV/cm; sweep rate: 0.1 μsec/cm.

Fig. 6-18. Typical displays obtained when performing step 13.

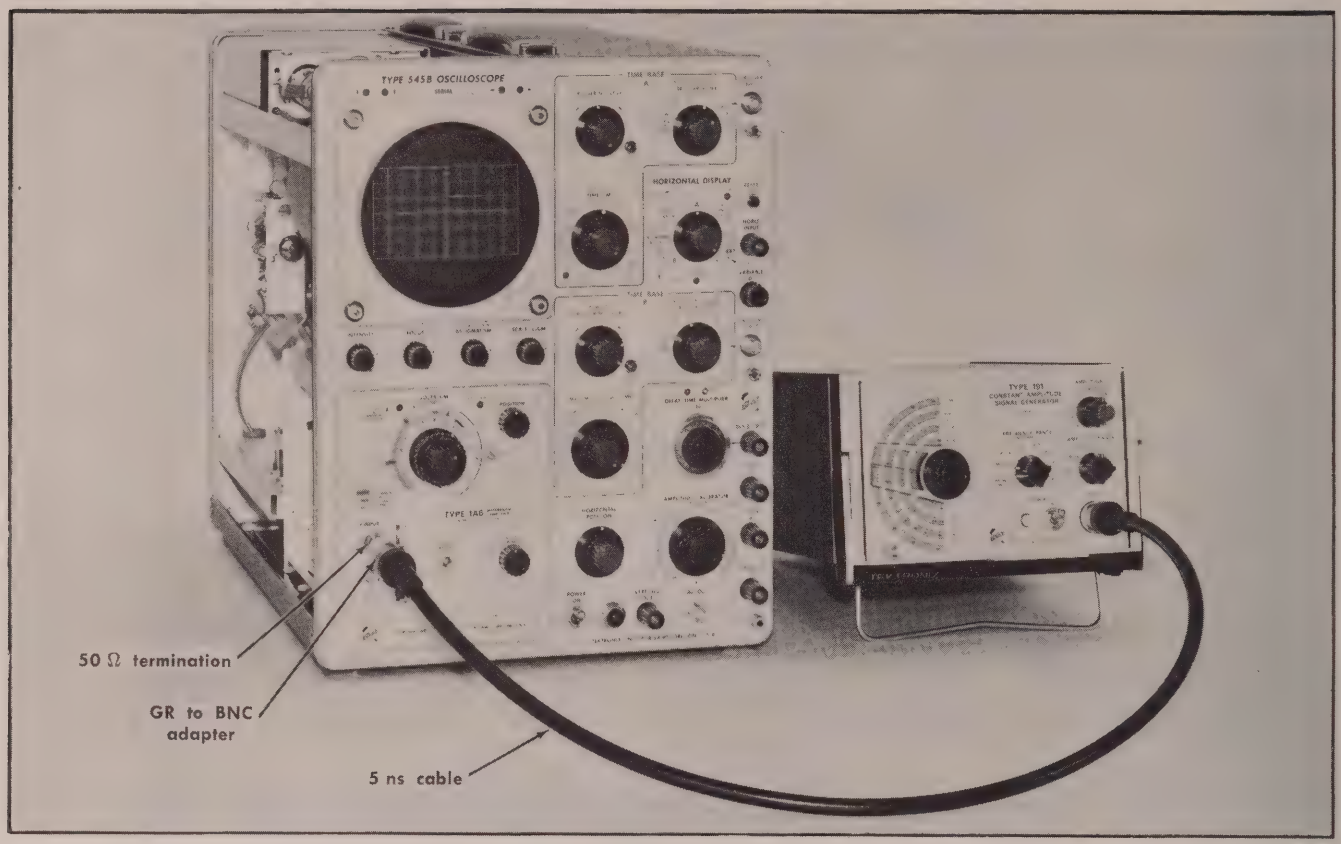


Fig. 6-19. Equipment setup for step 14.

Type 1A6	
VOLTS/CM	50 mVOLTS
VARIABLE	CAL
POSITION	Midrange or centered trace
VARIABLE BALANCE	Adjust for minimum trace movement as the VARIABLE control is rotated.
STEP ATTEN BALANCE	Adjusted for minimum vertical trace movement as the VOLTS/CM switch is rotated between the 50 mV to 1 mV range.
+INPUT Selector Switch	DC
—INPUT Selector Switch	GND

Test Oscilloscope	
Horizontal Display	Norm or Time Base A
Time/Cm	.5 mSEC
Variable	Calibrated
Triggering Mode	Int AC
Trigger Slope	—
Stability	Preset
Triggering Level	Adjust for stable display

Constant Amplitude Signal Generator (Type 191)	
Frequency	**50 kHz**

NOTES

14. Check Bandwidth

a. Equipment setup is shown in Fig. 6-19.

b. Apply the output signal of the Constant Amplitude Signal Generator to the +INPUT connector through a coaxial cable and a 50 ohm termination.

c. With a signal frequency of 50 kHz and the VOLTS/CM switch set to 50 mVOLTS position, adjust the amplitude control for a display amplitude of 4 cm.

d. Increase the output frequency of the Constant Amplitude Signal Generator until the display amplitude has decreased to 2.8 cm. See Fig. 6-20.

e. Check—Constant Amplitude Signal Generator frequency must be equal to or higher than 2 MHz.

f. Remove the signal and cables from the Type 1A6.

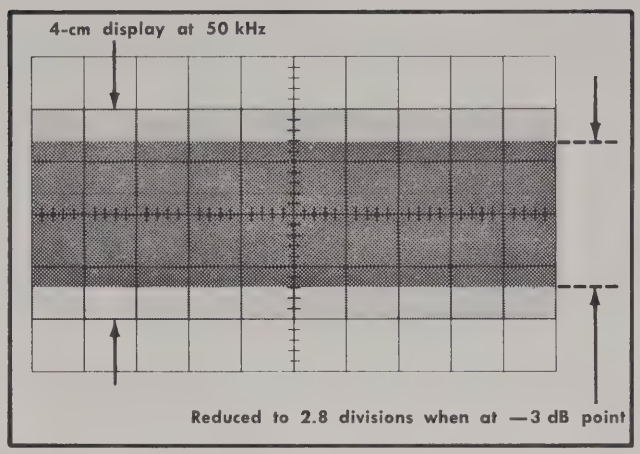


Fig. 6-20. Double exposure to show CRT display when checking the frequency response.

NOTES

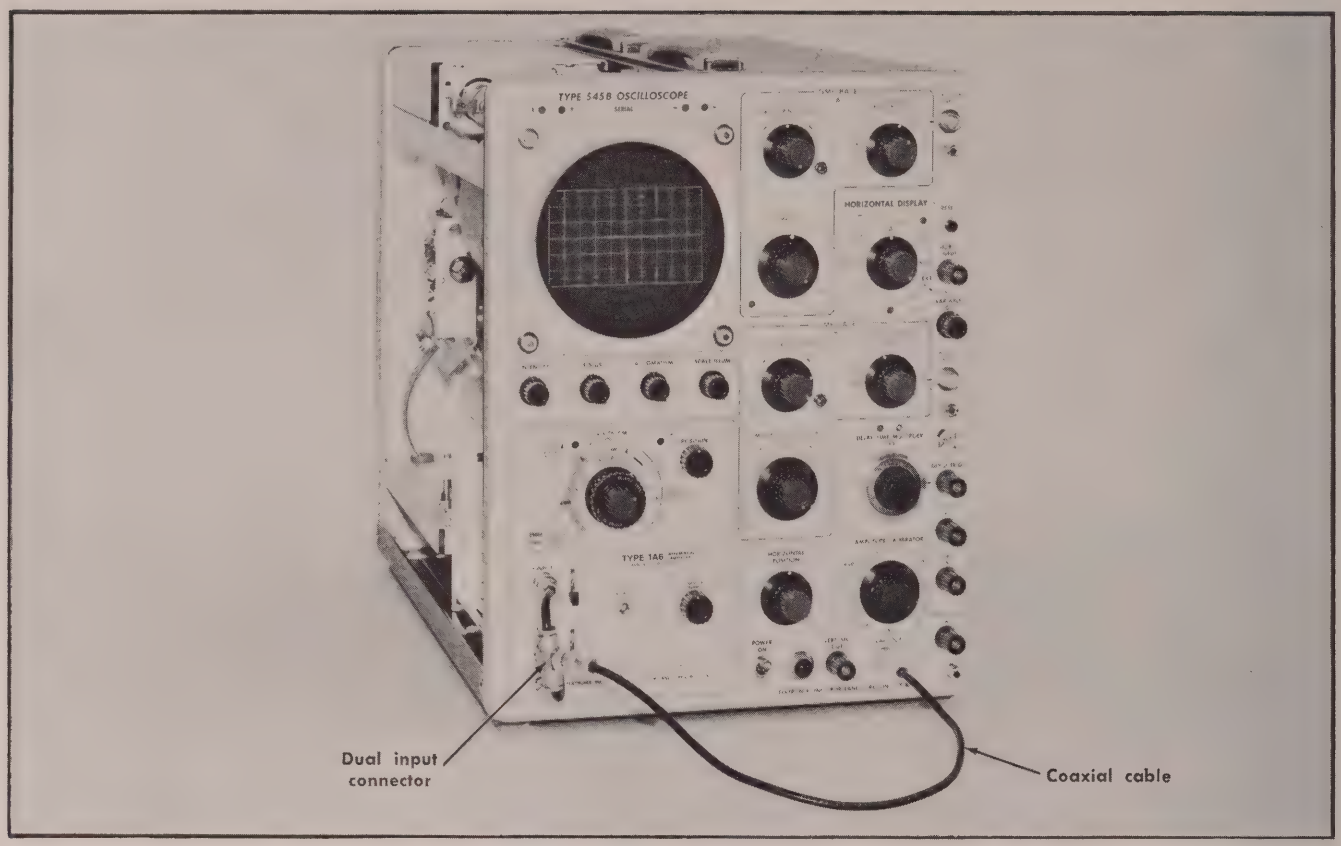


Fig. 6-21. Equipment setup for step 15.

Type 1A6

VOLTS/CM	50 mVOLTS
VARIABLE	CAL
POSITION	Midrange or centered
VARIABLE BALANCE	Adjusted for minimum trace movement as the VARIABLE control is rotated.
STEP ATTEN BALANCE	Adjusted for minimum vertical trace movement as the VOLTS/CM switch is rotated between the 50 mv to 1 mV range
+INPUT Selector Switch	DC
—INPUT Selector Switch	**DC**

Test Oscilloscope

Horizontal Display	Norm or Time Base A
Time/Cm	.5 mSEC
Variable	Calibrated
Triggering Mode	Int AC
Trigger Slope	—
Stability	Preset
Triggering Level	Adjust for stable display

NOTES

15. Check Operation of Input Overload Indicator

a. Equipment setup is shown in Fig. 6-21.

b. Apply the calibrator signal through a patch cord and dual input connector to both input connectors for the Type 1A6. Set both Input Selector switches to DC position.

c. With the VOLTS/CM switch in the 50 mVOLTS position increase the Amplitude Calibrator output until the INPUT OVERLOAD neon lights.

d. OVERLOAD INDICATOR must light at 50 volts and extinguish with less than 20 volts applied.

e. Reduce the Amplitude Calibrator setting, then change the —Input selector switch to GND position. Again check the operation of the OVERLOAD INDICATOR. Neon must again light with an input of approximately 50 volts and extinguish with less than 20 volts applied.

f. Reduce the setting of the Amplitude Calibrator output, set the —Input selector switch to DC and set the +Input selector switch to GND.

g. Check the operation of the OVERLOAD INDICATOR for the —Input side of the amplifier.

This completes the calibration of the Type 1A6. If the instrument has been completely calibrated to the tolerances given in the procedure it will perform to the limits given in the Characteristics section of this manual.

NOTES

NOTES

PARTS LIST ABBREVIATIONS

BHB	binding head brass
BHS	binding head steel
cap.	capacitor
cer	ceramic
comp	composition
conn	connector
CRT	cathode-ray tube
csk	countersunk
DE	double end
dia	diameter
div	division
elect.	electrolytic
EMC	electrolytic, metal cased
EMT	electrolytic, metal tubular
ext	external
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
h	height or high
hex.	hexagonal
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
ID	inside diameter
inc	incandescent
int	internal
lg	length or long
met.	metal
mtg hdw	mounting hardware
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
P/O	part of
PHB	pan head brass
PHS	pan head steel
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
RHB	round head brass
RHS	round head steel
SE	single end
SN or S/N	serial number
S or SW	switch
TC	temperature compensated
THB	truss head brass
thk	thick
THS	truss head steel
tub.	tubular
var	variable
w	wide or width
WW	wire-wound

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.

SECTION 7

ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description				S/N Range
		Bulbs				
B123	150-0055-00	Neon, 5AB-B		INPUT OVERLOAD		
B151	150-0035-00	Neon, A1D T2		UNCAL		
		Capacitors				
Tolerance ±20% unless otherwise indicated.						
C1[1]	*295-0081-00	0.1 μF	MT	600 V	10%	
C2	281-0629-00	33 pF	Cer	600 V	5%	
C10[1]	*295-0081-00	0.1 μF	MT	600 V	10%	
C11	281-0629-00	33 pF	Cer	600 V	5%	
C20B	281-0103-00	1.8-13 pF	Air Var			
C20C	281-0103-00	1.8-13 pF	Air Var			
C20D	281-0622-00	47 pF	Cer	500 V	1%	100-838
C20D	283-0603-00	113 pF	Mica	300 V	2%	839-up
C20E	281-0616-00	6.8 pF	Cer	200 V		X839-up
C22B	281-0103-00	1.8-13 pF	Air Var			
C22C	281-0103-00	1.8-13 pF	Air Var			
C22D	283-0594-00	0.001 μF	Mica	100 V	1%	
C24A	281-0544-00	5.6 pF	Cer	500 V	10%	
C24B	281-0103-00	1.8-13 pF	Air Var			
C24C	281-0100-00	1.4-7.3 pF	Air Var			
C24D	283-0617-00	4700 pF	Mica	300 V	10%	
C30B	281-0103-00	1.8-13 pF	Air Var			
C30C	281-0103-00	1.8-13 pF	Air Var			
C30D	281-0622-00	47 pF	Cer	500 V	1%	100-838
C30D	283-0603-00	113 pF	Mica	300 V	2%	839-up
C30E	281-0616-00	6.8 pF	Cer	200 V		X839-up
C32B	281-0103-00	1.8-13 pF	Air Var			
C32C	281-0103-00	1.8-13 pF	Air Var			
C32D	283-0594-00	0.001 μF	Mica	100 V	1%	
C34A	281-0544-00	5.6 pF	Cer	500 V	10%	
C34B	281-0103-00	1.8-13 pF	Air Var			
C34C	281-0100-00	1.4-7.3 pF	Air Var			
C34D	283-0617-00	4700 pF	Mica	300 V	10%	
C103	281-0100-00	1.4-7.3 pF	Air Var			
C112	281-0064-00	0.2-1.5 pF	Tub. Var			
C113	281-0619-00	1.2 pF	Cer	200 V		
C128	285-0626-00	0.0015 μF	PTM	100 V	10%	
C136	281-0116-00	1.6-9.1 pF	Air Var			
C140	281-0116-00	1.6-9.1 pF	Air Var			

[1]C1 and C10 matched within 1% of each other, furnished as a unit.

Capacitors *(Cont)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
C146	283-0079-00	0.01 μF	Cer	250 V		
C168	290-0267-00	1 μF	EMT	35 V		
C178	281-0547-00	2.7 pF	Cer	500 V	10%	
C193	281-0523-00	100 pF	Cer	350 V	20%	100-838
C193	281-0540-00	51 pF	Cer	500 V	5%	839-up
C203	281-0100-00	1.4-7.3 pF	Air	Var		
C212	281-0064-00	0.2-1.5 pF	Tub.	Var		
C213	281-0619-00	1.2 pF	Cer	200 V		
C246	283-0079-00	0.01 μF	Cer	250 V		
C278	281-0547-00	2.7 pF	Cer	500 V	10%	

Diodes

D108	152-0089-00	Zener	10M12.6Z5 10 W, 12.6 V, 5%
D115	*152-0165-00	Silicon	Selected from 1N3579
D168	152-0024-00	Zener	1N3024B 1 W, 15 V, 5%
D215	*152-0165-00	Silicon	Selected from 1N3579

Connectors

J1	131-0106-00	Coaxial, 1 contact, female
J10	131-0106-00	Coaxial, 1 contact, female
P11	131-0017-00	Chassis mtd., 16 contact, male

Inductors

L50	276-0507-00	Core, ferramic suppressor
L118	108-0318-00	100 μH
L218	108-0318-00	100 μH
L278	276-0507-00	Core, ferramic suppressor

Transistors

Q114	151-0150-00	Silicon	2N3440	100-549
Q114†	*153-0536-00	Silicon	2N3440, checked	550-up
Q123	151-0150-00	Silicon	2N3440	
Q128	*151-0134-00	Silicon	Replaceable by 2N2905	
Q138	151-0150-00	Silicon	2N3440	
Q144A,B	*151-0176-00	Silicon	Dual Replaceable by 2N3409	
Q164A,B	*151-0178-00	Silicon	Dual Replaceable by 2N3808	
Q168	151-0150-00	Silicon	2N3440	
Q184	151-0188-00	Silicon	2N3906	
Q194	151-0188-00	Silicon	2N3906	
Q214	151-0150-00	Silicon	2N3440	100-549
Q214†	*153-0536-00	Silicon	2N3440, checked	550-up
Q284	151-0188-00	Silicon	2N3906	
Q294	151-0188-00	Silicon	2N3906	

†Q114 and Q214 SN 550-up furnished as a matched pair.

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Resistors

Ckt. No.	Tektronix Part No.	Description				S/N Range
Resistors are fixed, composition, ±10% unless otherwise indicated.						
R2	316-0105-00	1 MΩ	¼ W			
R11	316-0105-00	1 MΩ	¼ W			
R20C	323-0611-01	900 kΩ	½ W	Prec	½%	
R20D	321-1389-01	111 kΩ	⅛ W	Prec	½%	
R22C	323-0614-01	990 kΩ	½ W	Prec	½%	
R22D	321-1289-01	10.1 kΩ	⅛ W	Prec	½%	
R24C	323-0623-01	999 kΩ	½ W	Prec	½%	
R24D	321-0193-01	1 kΩ	⅛ W	Prec	½%	
R30C	323-0611-01	900 kΩ	½ W	Prec	½%	
R30D	321-0389-01	110 kΩ	⅛ W	Prec	½%	
R30E	311-0010-00	2.5 kΩ		Var		
R32C	323-0614-01	990 kΩ	½ W	Prec	½%	
R32D	321-0289-01	10 kΩ	⅛ W	Prec	½%	
R32E	311-0616-00	250 Ω		Var		
R34C	323-0623-01	999 kΩ	½ W	Prec	½%	
R34D	321-0191-00	953 Ω	⅛ W	Prec	1%	
R34E	311-0615-00	100 Ω		Var		
R51A	322-0239-01	3.01 kΩ	¼ W	Prec	½%	
R51B	322-0663-01	752 Ω	¼ W	Prec	½%	
R51C	322-0662-01	334 Ω	¼ W	Prec	½%	
R51D	322-0116-01	158 Ω	¼ W	Prec	½%	
R51E	322-0661-01	61.4 Ω	¼ W	Prec	½%	
R101	311-0017-00	10 kΩ		Var		
R102	323-0385-00	100 kΩ	½ W	Prec	1%	
R103	323-0481-01	1 MΩ	½ W	Prec	½%	
R105	322-0097-00	100 Ω	¼ W	Prec	1%	
R107	308-0060-00	210 Ω	10 W	WW	5%	
R108	308-0060-00	210 Ω	10 W	WW	5%	
R110	311-0620-00	15 Ω		Var		
R115	322-0097-00	100 Ω	¼ W	Prec	1%	
R116	322-0612-00	500 Ω	¼ W	Prec	1%	
R118	323-0239-00	3.01 kΩ	½ W	Prec	1%	
R120	322-0337-00	31.6 kΩ	¼ W	Prec	1%	100-849
R120	322-0336-00	30.9 kΩ	¼ W	Prec	1%	850-up
R122	316-0104-00	100 kΩ	¼ W			
R124	323-0362-00	57.6 kΩ	½ W	Prec	1%	100-849
R124	323-0364-00	60.4 kΩ	½ W	Prec	1%	850-up
R126	322-0258-00	4.75 kΩ	¼ W	Prec	1%	100-849
R126	322-0270-00	6.34 kΩ	¼ W	Prec	1%	850-up
R128	315-0272-00	2.7 kΩ	¼ W		5%	
R129	322-0337-00	31.6 kΩ	¼ W	Prec	1%	100-849
R129	322-0336-00	30.9 kΩ	¼ W	Prec	1%	850-up
R130	316-0475-00	4.7 MΩ	¼ W			
R131	322-0335-00	30.1 kΩ	¼ W	Prec	1%	
R132	323-0393-00	121 kΩ	½ W	Prec	1%	
R134	308-0310-00	12 kΩ	5 W	WW	1%	
R136	322-0341-00	34.8 kΩ	¼ W	Prec	1%	
R137	322-0367-00	64.9 kΩ	¼ W	Prec	1%	
R138	322-0481-00	1 MΩ	¼ W	Prec	1%	

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
R139	311-0512-00	2 MΩ		Var		
R142	322-1386-00	104 kΩ	¼ W	Prec	1%	
R143[2]	311-0619-00	2 kΩ		Var		
R144	308-0409-00	4 kΩ	10 W	WW	1%	
R146	322-0137-00	261 Ω	¼ W	Prec	1%	
R148	308-0410-00	6 kΩ	5 W	WW	1%	
R149	322-0145-00	316 Ω	¼ W	Prec	1%	
R150[3]	*311-0627-00	1.5 kΩ		Var		
R151	316-0184-00	180 kΩ	¼ W			
R153	323-0353-00	46.4 kΩ	½ W	Prec	1%	
R155[4]	311-0619-00	2 kΩ		Var		
R158	322-0193-00	1 kΩ	¼ W	Prec	1%	
R161	322-0193-00	1 kΩ	¼ W	Prec	1%	
R164	308-0412-00	8.2 kΩ	3 W	WW	1%	
R168	305-0123-00	12 kΩ	2 W		5%	100-729
R168	305-0682-00	6.8 kΩ	2 W		5%	730-up
R169	322-0289-00	10 kΩ	¼ W	Prec	1%	
R172	322-0223-00	2.05 kΩ	¼ W	Prec	1%	
R173	311-0462-00	1 kΩ		Var		
R180	322-0237-00	2.87 kΩ	¼ W	Prec	1%	
R182	308-0413-00	16 kΩ	3 W	WW	1%	
R183	322-0157-00	422 Ω	¼ W	Prec	1%	
R185	311-0095-00	500 Ω		Var		
R188	323-0314-00	18.2 kΩ	½ W	Prec	1%	
R189	311-0008-00	2 kΩ		Var		
R190	308-0411-00	6.7 kΩ	3 W	WW	1%	
R192	315-0101-00	100 Ω	¼ W		5%	
R195	323-0210-00	1.5 kΩ	½ W	Prec	1%	
R198	323-0385-00	100 kΩ	½ W	Prec	1%	
R201	311-0017-00	10 kΩ		Var		
R202	323-0385-00	100 kΩ	½ W	Prec	1%	
R203	323-0481-01	1 MΩ	½ W	Prec	½%	
R205	322-0097-00	100 Ω	¼ W	Prec	1%	
R215	322-0097-00	100 Ω	¼ W	Prec	1%	
R216	322-0612-00	500 Ω	¼ W	Prec	1%	
R218	323-0239-00	3.01 kΩ	½ W	Prec	1%	
R238	322-0481-00	1 MΩ	¼ W	Prec	1%	
R242	322-0385-00	100 kΩ	¼ W	Prec	1%	
R243[5]	311-0619-00	10 kΩ		Var		
R244	308-0409-00	4 kΩ	10 W	WW	1%	
R246	322-0137-00	261 Ω	¼ W	Prec	1%	

[2]Furnished as a unit with R243.

[3]Furnished as a unit with SW151.

[4]Furnished as a unit with R255.

[5]Furnished as a unit with R143.

©

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R248	308-0410-00	6 kΩ	5 W		WW	1%	
R249	322-0145-00	316 Ω	¼ W		Prec	1%	
R253	323-0349-00	42.2 kΩ	½ W		Prec	1%	
R255[6]	311-0619-00	10 kΩ		Var			
R258	322-0193-00	1 kΩ	¼ W		Prec	1%	
R261	322-0193-00	1 kΩ	¼ W		Prec	1%	
R264	308-0412-00	8.2 kΩ	3 W		WW	1%	
R269	322-0289-00	10 kΩ	¼ W		Prec	1%	
R272	322-0223-00	2.05 kΩ	¼ W		Prec	1%	
R280	322-0237-00	2.87 kΩ	¼ W		Prec	1%	
R282	308-0413-00	16 kΩ	3 W		WW	1%	
R283	322-0157-00	422 Ω	¼ W		Prec	1%	
R288	323-0314-00	18.2 kΩ	½ W		Prec	1%	
R290	308-0411-00	6.7 kΩ	3 W		WW	1%	
R292	315-0101-00	100 Ω	¼ W			5%	
R293	316-0101-00	100 Ω	¼ W				

Switches

	Unwired	Wired			S/N Range
SW1	260-0600-00		Lever	AC-GND-DC	
SW10	260-0600-00		Lever	AC-GND-DC	
SW40	260-0794-00	*262-0777-00	Rotary	VOLTS/CM	100-838
SW40	260-0794-00	*262-0777-01	Rotary	VOLTS/CM	839-up
SW50	260-0516-00		Push	Micro	
SW151[7]					

Electron Tubes

V114, V214	*157-0109-00	8393, checked (1 pair)	100-889
V114, V214	*157-0126-00	8393, checked (1 pair)	890-up

[6]Furnished as a unit with R155.

[7]Furnished as a unit with R150.

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accomodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS

(Located behind diagrams)

FIG. 1	FRONT
FIG. 2	REAR

SECTION 8
MECHANICAL PARTS LIST

FIG. 1 FRONT

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-1	333-0938-01			1		PANEL, front
-2	366-0038-00			1		KNOB, red—VARIABLE
	- - - - - -			-		knob includes:
	213-0004-00			1		SCREW, set, 6-32 x 3/16 inch, HSS
-3	366-0372-00			1		KNOB, charcoal—VOLTS/CM
	- - - - - -			-		knob includes:
	213-0022-00			1		SCREW, set, 4-40 x 3/16 inch, HSS
-4	331-0147-01			1		DIAL, window
	- - - - - -			-		dial includes:
	213-0022-00			2		SCREW, set, 4-40 x 3/16 inch, HSS
-5	366-0113-00			1		KNOB, charcoal—POSITION
	- - - - - -			-		knob includes:
	213-0004-00			1		SCREW, set, 6-32 x 3/16 inch, HSS
-6	- - - - - -			2		RESISTOR, variable
	- - - - - -			-		mounting hardware for each: (not included w/resistor)
-7	210-0207-00			1		LUG, solder, 3/8 ID x 5/8 inch OD, SE
-8	210-0012-00			1		LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-9	210-0840-00			1		WASHER, flat, 0.390 ID x 9/16 inch OD
-10	210-0413-00			1		NUT, hex., 3/8-32 x 1/2 inch
-11	366-0215-01			1		KNOB, lever—INPUT SELECTOR +
-12	260-0600-00			1		SWITCH, unwired—INPUT SELECTOR +
	- - - - - -			-		mounting hardware: (not included w/switch)
-13	220-0413-00			2		NUT, hex., 4-40 x 0.562 inch long
-14	366-0215-01			1		KNOB, lever—INPUT SELECTOR —
-15	260-0600-00			1		SWITCH, unwired—INPUT SELECTOR —
	- - - - - -			-		mounting hardware: (not included w/switch)
-16	220-0413-00			2		NUT, hex., 4-40 x 0.562 inch long
-17	366-0113-00			1		KNOB, charcoal—VARIABLE BALANCE
	- - - - - -			-		knob includes:
	213-0004-00			1		SCREW, set, 6-32 x 3/16 inch, HSS
-18	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resistor)
-19	210-0207-00			1		LUG, solder, 3/8 ID x 5/8 inch OD, SE
-20	210-0012-00			2		LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-21	210-0494-00			1		NUT, hex., 3/8-32 x 1/2 x 11/16 inch
-22	358-0010-00			1		BUSHING
-23	131-0106-00			2		CONNECTOR, coaxial, 1 contact, BNC w/hardware

FIG. 1 FRONT *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
1-24	129-0053-00			1	ASSEMBLY, binding post
	- - - - - -			-	assembly includes:
	355-0507-00			1	STEM
	200-0103-00			1	CAP
	- - - - - -			-	mounting hardware: (not included w/assembly)
	210-0046-00			1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
-25	210-0455-00			1	NUT, hex., 1/4-28 x 3/8 x 3/32 inch
-26	366-0125-00			1	KNOB, plug-in securing
	- - - - - -			-	knob includes:
	213-0005-00			1	SCREW, set, 8-32 x 1/8 inch, HSS
-27	384-0510-00			1	ROD, securing
	- - - - - -			-	rod includes:
-28	354-0025-00			1	RING, retaining
-29	210-0894-00			1	WASHER, plastic, 0.190 ID x 7/16 inch OD
-30	337-0825-00			1	SHIELD
	- - - - - -			-	mounting hardware: (not included w/shield)
-31	210-0586-00			3	NUT, keps, 4-40 x 1/4 inch
-32	337-0827-00			1	SHIELD
	- - - - - -			-	mounting hardware: (not included w/shield)
-33	210-0586-00			1	NUT, keps, 4-40 x 1/4 inch
-34	210-0851-00			2	WASHER, flat, 0.119 ID x 3/8 inch OD
-35	211-0008-00			2	SCREW, 4-40 x 1/4 inch, PHS
-36	- - - - - -			2	CAPACITOR
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
-37	354-0068-00			1	RING, securing, plastic, 1/2 ID x 9/16 inch OD
-38	348-0031-00			2	GROMMET, plastic, 1/4 inch diameter
-39	337-0826-00			1	SHIELD
	- - - - - -			-	mounting hardware: (not included w/shield)
-40	210-0851-00			4	WASHER, flat, 0.119 ID x 3/8 inch OD
-41	211-0008-00			4	SCREW, 4-40 x 1/4 inch, PHS
-42	352-0084-00			2	HOLDER, neon, black plastic, 0.450 diameter x 0.650 inch
-43	378-0541-00			2	FILTER, lens
-44	200-0609-00			1	CAP, neon holder, plastic, 0.16 inch long
-45	200-0643-00			1	CAP, neon holder, plastic, 0.590 inch long
-46	407-0251-00			1	BRACKET
	- - - - - -			-	mounting hardware: (not included w/bracket)
-47	348-0087-00			4	MOUNT, rubber
-48	361-0113-00			8	SPACER, plastic
-49	136-0226-00			2	SOCKET, nuvistor, 5 pin

FIG. 1 FRONT *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-50	200-0554-00			1		COVER, heat stabilizer
	- - - - - -			-		mounting hardware: (not included w/cover)
-51	211-0516-00			1		SCREW, 6-32 x 7/8 inch, PHS
-52	377-0103-00			2		INSERT, heat stabilizer
-53	210-0202-00			1		LUG, solder, SE #6
	- - - - - -			-		mounting hardware: (not included w/lug)
-54	213-0044-00			1		SCREW, thread forming, 5-32 x 3/16 inch, PHS
-55	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resistor)
-56	210-0940-00			1		WASHER, flat, 1/4 ID x 3/8 inch OD
-57	210-0583-00			1		NUT, hex., 1/4-32 x 5/16 inch
-58	376-0053-00			1		COUPLING, shaft
	- - - - - -			-		coupling includes:
	213-0048-00			2		SCREW, set, 4-40 x 1/8 inch, HSS
-59	384-0404-00			1		ROD, extension
-60	358-0216-00			1		BUSHING
	670-0111-00			1		ASSEMBLY, circuit board
	- - - - - -			-		assembly includes:
-61	388-0732-00			1		BOARD, circuit
	- - - - - -			-		board includes:
-62	214-0506-00			10		PIN, connector
	670-0111-00			1		ASSEMBLY, circuit board
	- - - - - -			-		assembly includes:
-63	388-0733-00			1		BOARD, circuit
	- - - - - -			-		board includes:
-64	214-0506-00			29		PIN, connector
-65	136-0220-00			4		SOCKET, transistor, 3 pin
-66	136-0235-00			2		SOCKET, transistor, dual
-67	136-0183-00			6		SOCKET, transistor, 3 pin
	- - - - - -			-		mounting hardware: (not included w/assembly)
-68	211-0116-00			4		SCREW, sems, 4-40 x 5/16 inch, PHB
-69	441-0677-00			1		CHASSIS
	- - - - - -			-		mounting hardware: (not included w/chassis)
-70	212-0040-00			4		SCREW, 8-32 x 3/8 inch, 100° csk, FHS
-71	210-0458-00			4		NUT, keps, 8-32 x 11/32 inch
	212-0004-00			3		SCREW, 8-32 x 5/16 inch, PHS (not shown)

FIG. 1 FRONT *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-72	131-0371-00			12		CONNECTOR
-73	179-1083-00			1		CABLE HARNESS
	- - - - - -			-		cable includes:
-74	131-0374-00			1		CONNECTOR
-75	131-0371-00			21		CONNECTOR
-76	386-1072-00			1		PLATE, sub-panel, front

FIG. 2 REAR

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
2-1	262-0777-00	100	838	1	SWITCH, wired—VOLTS/CM
	262-0777-01	839		1	SWITCH, wired—VOLTS/CM
	- - - - - -			-	switch includes:
	260-0794-00			1	SWITCH, unwired—VOLTS/CM
-2	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	resistor includes:
	213-0022-00			1	SCREW, set, 4-40 x 3/16 inch, HSS
	- - - - - -			-	mounting hardware: (not included w/resistor)
-3	211-0015-00			2	SCREW, 4-40 x 1/2 inch, RHS
-4	166-0025-00			2	TUBE, spacer, 0.125 ID x 3/16 OD x 1/4 inch long
-5	260-0516-00			1	SWITCH, unwired
	- - - - - -			-	mounting hardware: (not included w/switch)
-6	211-0034-00			2	SCREW, 2-56 x 1/2 inch, RHS
-7	210-0001-00			2	LOCKWASHER, internal #2
-8	210-0405-00			2	NUT, hex., 2-56 x 3/16 inch
-9	210-0449-00			2	NUT, hex., 5-40 x 1/4 inch
-10	129-0093-00			2	POST, hex., 0.250 x 0.875 inch long
-11	131-0371-00			7	CONNECTOR, coaxial, single contact
	610-0180-00	100	838	1	ASSEMBLY, attenuator
	610-0180-01	839		1	ASSEMBLY, attenuator
	- - - - - -			-	assembly includes:
-12	- - - - - -			14	CAPACITOR
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
-13	214-0456-00			1	FASTENER, plastic
-14	- - - - - -			5	CAPACITOR
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
-15	210-0438-00			2	NUT, hex., 1-72 x 5/32 inch
-16	441-0676-00			1	CHASSIS, attenuator
	- - - - - -			-	mounting hardware: (not included w/chassis)
-17	211-0007-00			2	SCREW, 4-40 x 3/16 inch, PHS
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0579-00			1	NUT, hex., 5/8-24 x 3/4 inch (not shown)
-18	210-0586-00			1	NUT, keps, 4-40 x 1/4 inch
-19	212-0004-00			2	SCREW, 8-32 x 5/16 inch, PHS
-20	131-0017-00			1	CONNECTOR, 16 contact
	- - - - - -			-	mounting hardware: (not included w/connector)
-21	211-0008-00			2	SCREW, 4-40 x 1/4 inch, PHS
-22	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
-23	210-0202-00			1	LUG, solder, SE #6
	- - - - - -			-	mounting hardware: (not included w/lug)
-24	211-0504-00			1	SCREW, 6-32 x 1/4 inch
-25	210-0407-00			1	NUT, 6-32 x 1/4 inch

FIG. 2 REAR *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
2-26	384-0631-00			4	ROD, spacer
	- - - - - -			-	mounting hardware for each: (not included w/rod)
-27	212-0044-00			1	SCREW, 8-32 x 1/2 inch, RHS
-28	- - - - - -			4	RESISTOR
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-29	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS
-30	210-0478-00			1	NUT, hex., 5/16 x 21/32 inch long
-31	210-0601-00			1	EYELET, 0.323 OD x 0.192 inch long
-32	211-0553-00			1	SCREW, 6-32 x 1 1/2 inches, RHS
-33	407-0245-00			1	BRACKET
	- - - - - -			-	mounting hardware: (not included w/bracket)
-34	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS
-35	- - - - - -			1	DIODE
	- - - - - -			-	mounting hardware: (not included w/diode)
-36	210-0010-00			1	LOCKWASHER, internal, #10
-37	210-0410-00			1	NUT, hex., 10-32 x 5/16 inch
-38	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-39	210-0207-00			1	LUG, solder, 3/8 ID x 5/8 inch OD, SE
-40	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-41	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-42	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-43	384-0405-00			1	ROD, extension shaft
-44	386-1080-00			1	PLATE, rear

STANDARD ACCESSORIES

	070-0537-00			2	MANUAL, instruction (not shown)

®

FIG. 2 REAR *(cont)*

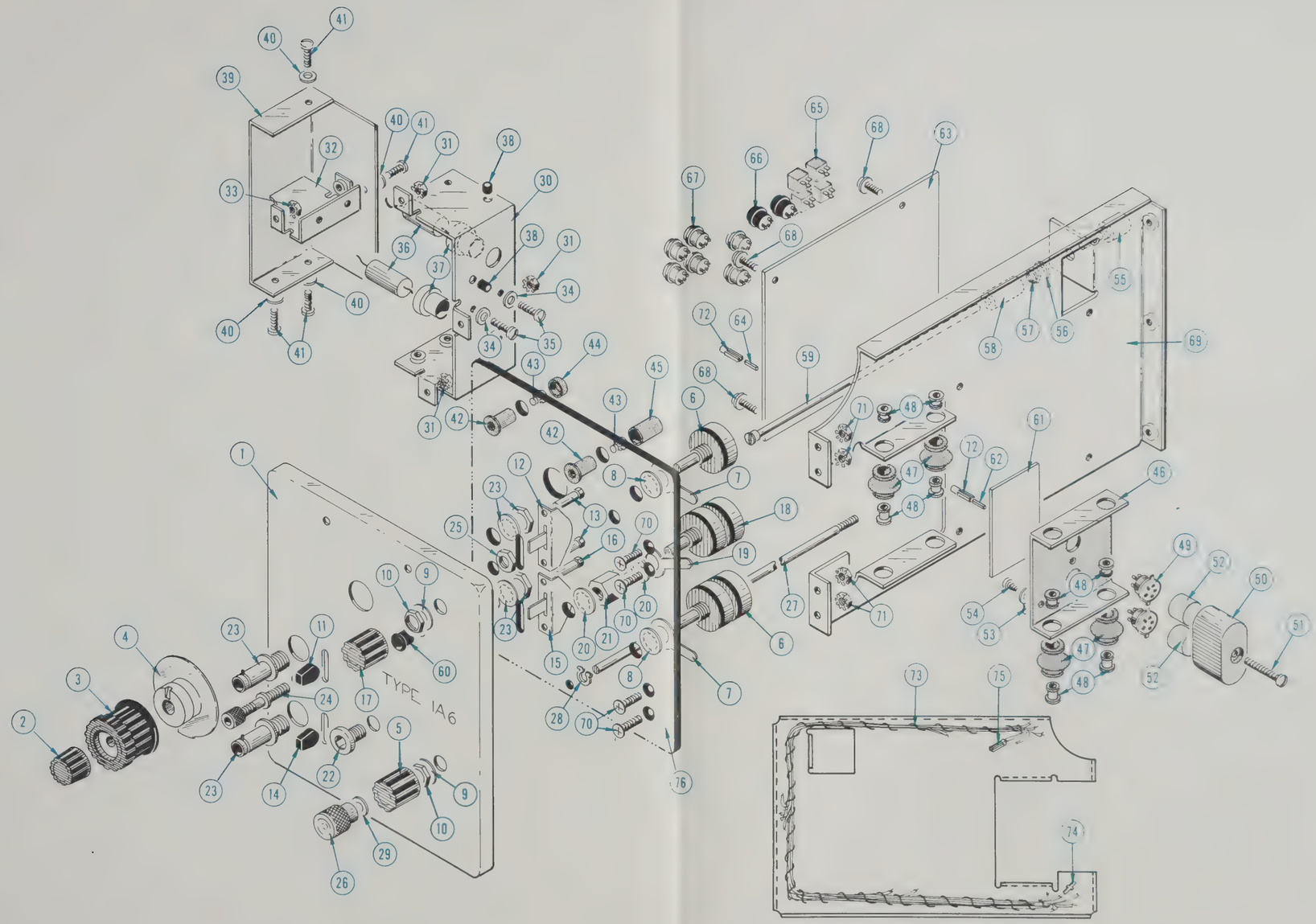
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
2-26	384-0631-00			4		ROD, spacer
	- - - - - -			-		mounting hardware for each: (not included w/rod)
-27	212-0044-00			1		SCREW, 8-32 x 1/2 inch, RHS
-28	- - - - - -			4		RESISTOR
	- - - - - -			-		mounting hardware for each: (not included w/resistor)
-29	211-0507-00			1		SCREW, 6-32 x 5/16 inch, PHS
-30	210-0478-00			1		NUT, hex., 5/16 x 21/32 inch long
-31	210-0601-00			1		EYELET, 0.323 OD x 0.192 inch long
-32	211-0553-00			1		SCREW, 6-32 x 1 1/2 inches, RHS
-33	407-0245-00			1		BRACKET
	- - - - - -			-		mounting hardware: (not included w/bracket)
-34	211-0507-00			2		SCREW, 6-32 x 5/16 inch, PHS
-35	- - - - - -			1		DIODE
	- - - - - -			-		mounting hardware: (not included w/diode)
-36	210-0010-00			1		LOCKWASHER, internal, #10
-37	210-0410-00			1		NUT, hex., 10-32 x 5/16 inch
-38	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resistor)
-39	210-0207-00			1		LUG, solder, 3/8 ID x 5/8 inch OD, SE
-40	210-0012-00			1		LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-41	210-0840-00			1		WASHER, flat, 0.390 ID x 9/16 inch OD
-42	210-0413-00			1		NUT, hex., 3/8-32 x 1/2 inch
-43	384-0405-00			1		ROD, extension shaft
-44	386-1080-00			1		PLATE, rear

STANDARD ACCESSORIES

	070-0537-00			2		MANUAL, instruction (not shown)

®

FIG.1 FRONT



MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

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